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PETROLOGIC AND ECONOMIC EVALUATION OF BLANCHET ISLAND, N.W.T.

by

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A THESIS

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ABSTRACT

Blanchet Island is located between longitudes 112°47' to 112°00'W and latitudes N62°00' to 61°52' in the East Arm of Great Slave Lake. The East Arm is thought to be an aulacogen associated with the Aphebian Coronation Geosyncline.

Approximately 1800 million years ago, near the end of the deposition of the Stark Formation, a differentiated sill intruded a synclinorium superimposed upon a minor northeast trending graben located on the southern half of Blanchet Island. Later, transcurrent movement along the faults bordering the graben moved the sill over the underlying sediments, causing small drag folds along the contact. Where these folds approached a chevron nature, brecciation occurred in the anticlinal apices and a favorable environment for ore deposition was created. The known ore bodies are small (100 - 200 tons) but are of very high grade, consisting of niccolite, rammelsbergite, safflorite, and minor silver. There are three possible sources for the mineralization, namely, hydrothermal leaching of the sill and sediments, percolation of fluids from the Seton Volcanics and solutions emanating from the upper mantle or lower crust.

The contact aureole of the sill is characterized by two main types of sulphide bearing skarns, a magnetite-hematite hornblende-hornfels and a hematite-magnetite-chlorite epidote hornfels. Contact metamorphism in the area is restricted mainly to the hornblende hornfels facies but there is some evidence of albite-epidote hornfels facies conditions away from the sill.

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CHAPTER ONE

GENERAL STATEMENT

During the course of the last fifty years, there has been increasing economic interest in the Aphebian rocks of Great Slave Lake. The area has been thoroughly prospected for gold. Later, interest was renewed with the discovery of radioactive actinolite-tremolite veins in quartz diorite laccoliths around Regina Bay. Prospecting for nickel-cobalt mineralization culminated in the discovery of a small high-grade deposit on Blanchet Island by Jason Explorations Company. More recently, Vestor Explorations Ltd. created renewed interest with the discovery of uranium mineralization throughout the East Arm in the Sosan Group.

This study was centered around one of the above deposits, that of Blanchet Island, N.W.T. The objective was to determine mineral controls and the nature of deposition of the ore deposit as well as to study the petrology of the country rocks.

Location and Accessibility of the Study Area

The study area lies approximately between longitudes 112°47'W to 112°00'W and latitudes N62°00' to 61°52'. (Fig. 1) It is easily accessible from Yellowknife, Hay River, or Fort Smith by chartered aircraft. The area can also be reached by water from any access point on Great Slave Lake. The field investigations for this study were carried out in the vicinity of the main showing on what are locally known as the Lux Group of claims. (Map 1)

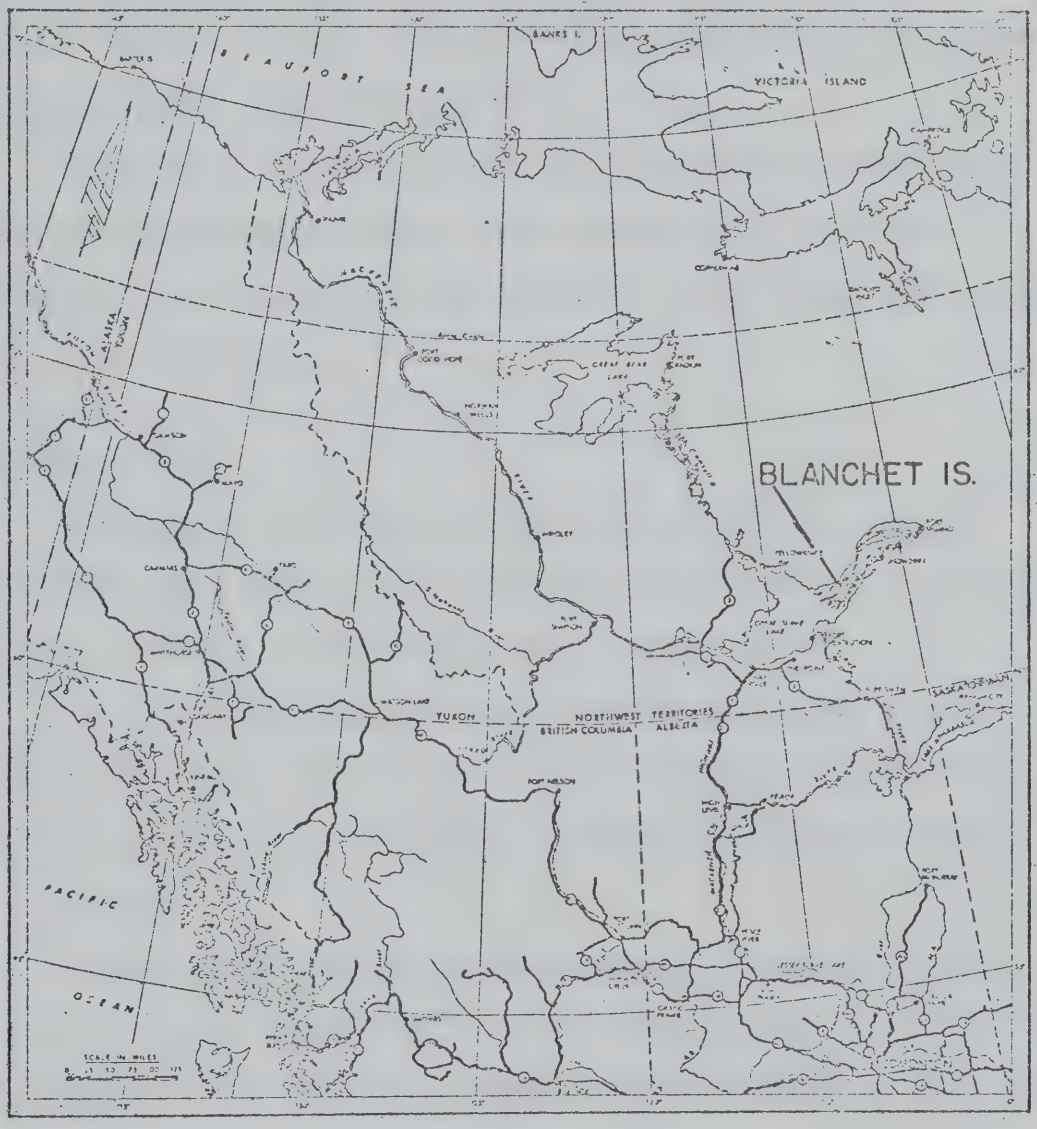

FIGURE 1 LOCATION MAP

Physiography

Blanchet Island rises from a 513 foot lake level to cliffs of up to one thousand feet high. The more resistive Pethei Formation forms the cliffs and this unit is capped by a "quartz diorite" sill.[1] The less resistive Stark and McLean Formations make up some of the smaller ridges just above lake level.

Drainage in the area is poor and the island is dotted with shallow lakes covering about twenty percent of the outcrop. Glacial till is negligible and therefore on the whole, the lithologic units are well exposed.

Previous Work

Geological investigations and mapping within the East Arm of Great Slave Lake have been conducted by officers of the Geological Survey of Canada since the beginning of this century.

In 1936, STOCKWELL published the first systematic mapping in the East Arm. His reports, together with maps 377A and 378A formed the basis of all subsequent geological investigations in the region.

BROWN (1950) produced preliminary maps of Christie Bay and Reliance areas, followed by Second Preliminary Maps of the same areas by WRIGHT in 1951 and 1952. BARNES produced preliminary maps for the Snowdrift Map area (1951) and McLean Bay Map area (1952). The most recent and detailed work on these Aphebian rocks in the East Arm of Great Slave Lake is that of HOFFMAN (1968). In this report, Hoffman reconstructed and added to Stockwell's existing stratigraphic

[1] The term quartz diorite is used here in an historic sense but it will be shown later that the term is not always applicable.

column. A paper by HOFFMAN (presently unpublished) discusses the origin of the East Arm and solves many of the structural problems formerly existing in the area.

The main lithologic map used in this study is an adaptation of an unpublished map by Hoffman constructed in 1972.

Methods and Scope of Investigation

This investigation involves studies on the stratigraphy, structure, mineralization, metasomatism and metamorphism of Lower Aphebian rocks exposed on Blanchet Island, N.W.T. and surrounding area.

The field aspect of this investigation centers around the main mine area (Lux Claims) of Blanchet Island. The mine is based upon a nickel-cobalt-bismuth deposit occurring on the contact between a "quartz diorite" sill and limestones of the Pethei Formation.

Samples of more pelitic rocks were gathered in the mine area as well as systematically away from the contact in attempts to discern the type and grade of metamorphism of the area. Structural data was gathered in some detail in attempts to discern structural controls. Lithologic samples from all significant units have been gathered in order to detect metasomatic as well as metamorphic changes.

Representative ore samples were gathered for studies of depositional controls, ore types and ore source.

CHAPTER TWO

REGIONAL GEOLOGIC SETTING

Introduction

Since the East Arm of Great Slave Lake has been mapped by several geologists at various times, it is understandable that the geology has been interpreted in various ways. I.C. BROWN (1950) gave the first generalized picture of the East Arm. He states that "The main body of Great Slave Lake crosses the boundary between the Canadian Shield and the bordering area of Palaeozoic rocks, and the east arm of the lake extends at right angles to the contact for 175 miles into Precambrian formations." This simplified explanation was extended by F.Q. BARNES (1952). He stated, "The entire lake basin appears to be a graben, thereby preserving the Proterozoic rocks from erosion. It is the writer's opinion that the lake basin in which the Proterozoic formations are preserved has been an area of weakness since before Proterozoic times and that is a principal reason why such an unusually great thickness of these strata is encountered."

In 1968, HOFFMAN incorporated these views and his own in a report that states, "More than 50,000 feet of unmetamorphosed[1] Precambrian sedimentary and volcanic rocks are exposed in the region of the East Arm of Great Slave Lake, District of Mackenzie.

[1] "unmetamorphosed" by straight definition cannot be used here. The P and T conditions at 50,000 ft. will be great enough to cause the upper zeolite facies metamorphism, if not lower green schist conditions. Besides this the abundance of dioritic to syenitic sill and dykes in the east arm suggest conditions of at least low grade regional metamorphism.

They occur in a fold belt 180 miles long and 60 miles wide which consists of an asymmetric, canoe-shaped synclinorium over which has been superimposed a Precambrian graben. Gently dipping Aphebian strata on the north side of the synclinorium overlie Archean rocks of the Slave Province. On the south side, tightly folded and faulted Archean, Aphebian and perhaps Paleohelikian sedimentary strata abut against gneissic rocks of the Churchill Province along the McDonald Fault system." This then describes the East Arm of Great Slave Lake but does not sufficiently explain its origin.

Origin of the East Arm, Great Slave Lake

In a recent but presently unpublished paper, HOFFMAN (in press-1) believes he has finally explained adequately the origin of the East Arm fold belt. He believes this belt is an 'aulacogen'.[1] The first application of the aulacogen theory to some of the major structures occurring on platforms was by SALOP and SCHEINMANN (1969).

Aulacogens are long-lived deeply subsiding troughs, at times fault-bounded, that extend from geosynclines far into adjacent foreland platforms. They are normally located where the geosyncline makes a re-entrant angle into the platform. Their fill is contemporaneous with, as thick as, and lithologically similar to, the foreland sedimentary wedge of the geosyncline, but with the addition of basalt and fanglomerate.

Therefore, this Proterozoic Athapuscow Aulacogen of Great Slave Lake began as an incipient rift during the miogeoclinal

[1]First described by Shatzky, N.S. 1955. On the Origin of the Pachelma Trough. Byull. Mosk. Obshchestva Lyubiteley Prirody, Otd. Geol., 5: 5-2b. (Paper was unavailable at the University of Alberta).

stage of the Coronation Geosyncline, (Figure 2). During the orogenic stage of the geosyncline, the aulacogen became a broader downwarp that received exogeosynclinal sediments from the orogenic belt. The aulacogen was compressed mildly, prior to a final stage involving transcurrent faulting, one-sided uplift, and continental fanglomerate sedimentation. The aulacogen is distinguished from the foreland sedimentary wedge of the geosyncline in that it has paleocurrents parallel rather than transverse to its structural trend, high angle faults (Hearne Channel Fault and McDonald Fault) rather than low angle thrusts and an alkalic basalt volcanism (Seton Formation).

Filling of the Athapuscow Aulacogen was in three stages--the first correlative with the Coronation miogeocline, the second with the Coronation exogeosyncline, and the third, following mild compression of the aulacogen, related to uplift in the Churchill Province and possibly transcurrent movement on the McDonald Fault system. The platform cover is relatively slightly deformed except around the overturned margins of large cold anticlinal basement uplifts east of the thrust front.

This explanation by Hoffman elucidated many large scale features in the East Arm and this study will attempt to show that it can also be used to explain features on a smaller scale.

Stratigraphy and Age

The Proterozoic rocks exposed within the East Arm of Great Slave Lake have previously been classified into seven groups (HOFFMAN, 1968) as shown in Table I. Figure 4 presents a stratigraphic cross section of the Proterozoic Formations from northeast

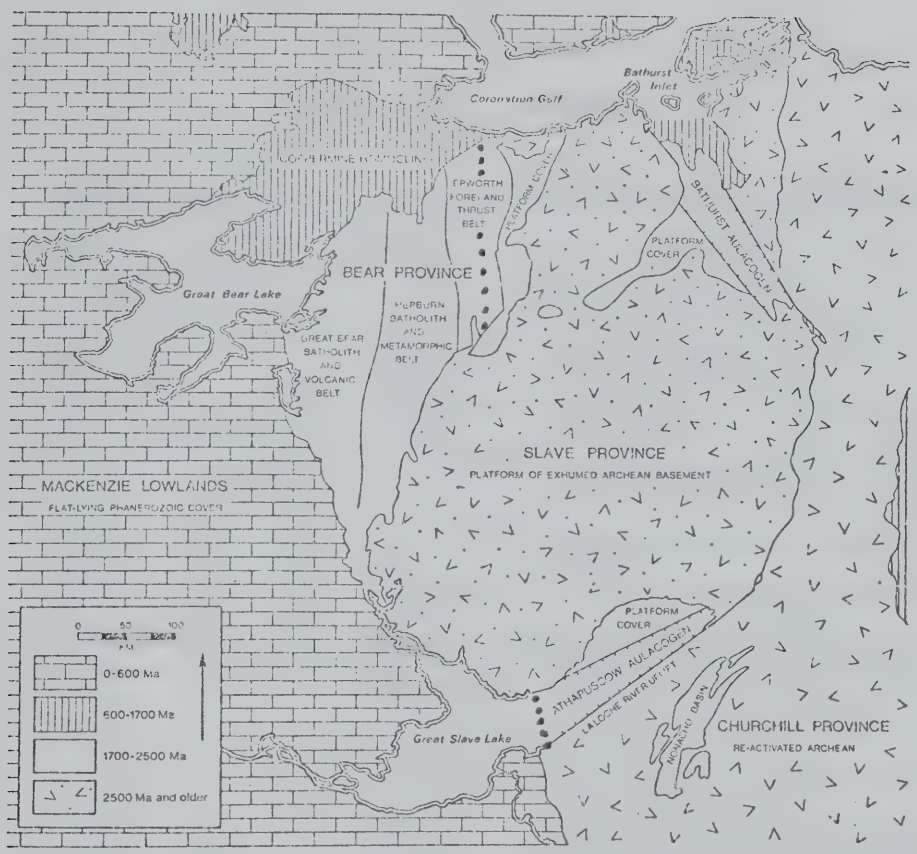

Figure 2: LOCATION OF MAJOR FEATURES

The heavy dotted line is the approximate hinge line of the Coronation Geosyncline.

after HOFFMAN (in press-1)

TABLE I

EON	ERA	SUPER-GROUP	GROUP	FORMATION	LITHOLOGY
PROTEROZOIC	PALEO-HELIKIAN	1295 m.y. Mackenzie Swarm			Diabase, northwest trending dykes
		Intrusive contact			
	APHEBIAN or PALEOHELIKIAN				Diabase, sills and shallow dipping dykes
		Intrusive contact			
			Et-then Group	Preble Formation 10,000 +	Sandstone, buff to red, feldspathic, weakly indurated, cross-bedded; minor conglomerate, shale
				Murky Formation 0 – 3,000	Conglomerate, buff to red, very thick bedded, weakly indurated; minor lithic sandstone lenses, shale, mudcracks, caliche horizons
	Unconformity				
	APHEBIAN	1845 m.y.			Quartz-diorite, laccoliths and minor dykes (may be older than the upper Stark Formation)
		Intrusive contact			
		GREAT SLAVE SUPERGROUP	Christie Bay Group	Pearson Formation 550 +	Basalt, columnar; minor argillite, argillite-pebble conglomerate
				Portage Inlet Formation 705	Shale, red to brown, mudcracked, halite and gypsum casts; minor thin beds of siltstone and sandstone
				Tochatwi Formation 1,870 – 2,600	Sandstone, red to buff, fine-grained, lithic and feldspathic, crossbedded, ripple-marked, mudcracked; minor conglomerate and shale
				Stark Formation 2,000 ?	Mudstone, red, brecciated, hematitic, halite casts; beds of inter-laminated dolomite and limestone, stromatolitic, ripple-marked, crossbedded, convolute bedded; extensive non-tectonic breccias
			Disconformity ?		
			Pethei Group	Hearne Formation 0 – 300	Limestone, grey to white, thick bedded, medium- to coarse-grained, crystalline, massive to mottled; minor stromatolitic limestone and dolomite
				Wildbread Formation 0 – 600 ?	Limestone, grey to white, thin- to medium-bedded, oolitic, stromatolitic, laminated, mottled, or crystaline; minor dolomite, stromatolitic; some sections extensively dolomitized
				Pekanatui Point Formation 0 – 340	Limestone, white, very thin bedded, aphanitic; very thinly inter-bedded limestone and argillite; argillite with limestone nodules; interbedded greywacke and argillite; nodular argillaceous dolomite and limestone; limestone 'debris flow' breccia beds; some sections extensively dolomitized
				Blanchet Formation 0 – 995	Greywacke, dark red-brown to dark green, thin-bedded, graded bedding, interbedded argillite and interlaminated argillite and limestone; argillite with limestone nodules
				McLean Formation 0 – 395	Argillite, red-brown, very thin bedded, calcareous, interbedded limestone or limestone nodules; some sections extensively dolomitized
				Utsingi Formation 0 – 900	Limestone, grey, medium- to thick-bedded, medium-grained, crystalline, mottled to laminated; minor stromatolitic limestone
				Taltheilei Formation 0 – 390	Dolomite, brown, medium- to thin-bedded, fine-grained, crystalline, stromatolitic, laminated, or massive; stromatolitic limestone with dolomite laminations; calcite cemented dolarenite, dolorudite
				Douglas Peninsula Formation 55 – 110	Marlstone, red-brown, laminated, gypsum casts; argillite, hematitic, limestone and jasper nodules

(after HOFFMAN 1968)

TABLE I continued

EON	ERA	SUPER-GROUP	GROUP	FORMATION	LITHOLOGY
PROTEROZOIC	APHEBIAN	GREAT SLAVE SUPERGROUP	Kahochella Group	Charlton Bay Formation 30 – 500	Argillite, dark green, calcareous concretions; minor graded siltstone beds, bentonite beds
				McLeod Bay Formation 450 – 1,050	Shale, red, calcareous concretions, intraformational concretion conglomerate; minor dark green argillite
				Gibralter Formation 600 – 3,450	Shale, red; minor oolitic hematite, intraformational conglomerate, stromatolites, marlstone beds, gypsum casts
				Seton Formation 0 – 4,300	Andesite, massive, columnar, or brecciated; basic ash-fall tuff, agglomerate; reworked basic lithic and vitric tuff, volcanic conglomerate; minor columnar rhyolite flows; minor sandstone, hematitic siltstone, oolitic hematite, gypsum casts
			Sosan Group	Akaitcho River Formation 0 – 1,000	Siltstone, red, micaceous, massive to ripple-marked, mud-cracked, thin-bedded; white, crossbedded glauconitic sandstone with Scolithus-like tubes; red, micaceous shale; minor oolitic hematite, conglomerate
				Kluziai Formation 1,450	Sandstone, pink, medium-grained, crossbedded, shale-pebble conglomerate, heavy mineral bands
				Unconformity ?	
				Duhamel Formation 0 – 915	Dolomite, stromatolitic, oolitic, intraformational conglomerate, chert nodules; crossbedded calcarenite and orthoquartzite; ripple-marked, mudcracked siltstone
				Hornby Channel Formation 0 – 5,000 +	Sandstone, coarse-grained, grey, crossbedded, feldspathic; minor conglomerate, stromatolitic dolomite, siltstone
		Unconformity ?			
			Union Island Group	unnamed	Dolomite, brown, massive, quartz veins
				unnamed	Volcanic rocks, basic, pillowed or brecciated flows; minor slate
				unnamed	Slate, grey; minor greywacke
				unnamed	Slate, black, carbonaceous; dark grey dolomite
				unnamed	Dolomite, massive to laminated; minor red argillite, arkose and conglomerate at base
Unconformity					
ARCHEAN	2460 m.y.				Granodiorite; migmatite; granite pegmatite
	Intrusive contact				
			Wilson Island Group	unnamed	Slate, dark grey; minor siltstone
				unnamed	Siltstone, light grey, thin-bedded, interbedded with dark grey argillite
				unnamed	Quartzite, grey to red to white, crossbedded; minor hematitic quartzite, argillite
				unnamed	Dolomite, grey to brown, massive to laminated; minor argillite, micaceous dolomite
				unnamed	Quartzite, grey to white, crossbedded; minor conglomerate, feldspathic quartzite
				unnamed	Volcanic rocks, dark grey to dark brown, porphyritic, sheared ignimbritic?

(after HOFFMAN 1968)

to southwest of the region. The formations involved in the Blanchet Island area will be discussed in some detail later.

All of the units mentioned here except the Et-then Group and possibly the Pearson Formation have been intruded by "quartz diorite laccoliths" dated by biotite K-Ar method at 1785 m.y., 1795 m.y., and 1845 m.y. (HOFFMAN, 1973, in press-1), (Figure 3).

Diabase dykes of the Mackenzie swarm dated as 1300 m.y. (FAHRIG and WANLESS, 1963) transect the Et-then group and the older rocks.

Structures of the East Arm

The East Arm of Great Slave Lake has been described as a fold belt 180 miles long and 60 miles wide which consists of an asymmetric, canoe-shaped synclinorium over which has been superimposed a Precambrian graben. This has more recently been interpreted as a fault bounded aulacogen involving transcurrent type graben faulting.

The accompanying figures show the prominent northeast trending faults in the East Arm and their interpretive cross-sectional representation (HOFFMAN, in press-1), (Figure 5).

The area is further characterized by many anticlines and synclines, whose axes parallel that of the synclinorium. The folding in the East Arm is related to the uplift and deformation of the Aphebian rocks in the Coronation geosyncline during the Hudsonian orogeny, (HOFFMAN, in press-1).

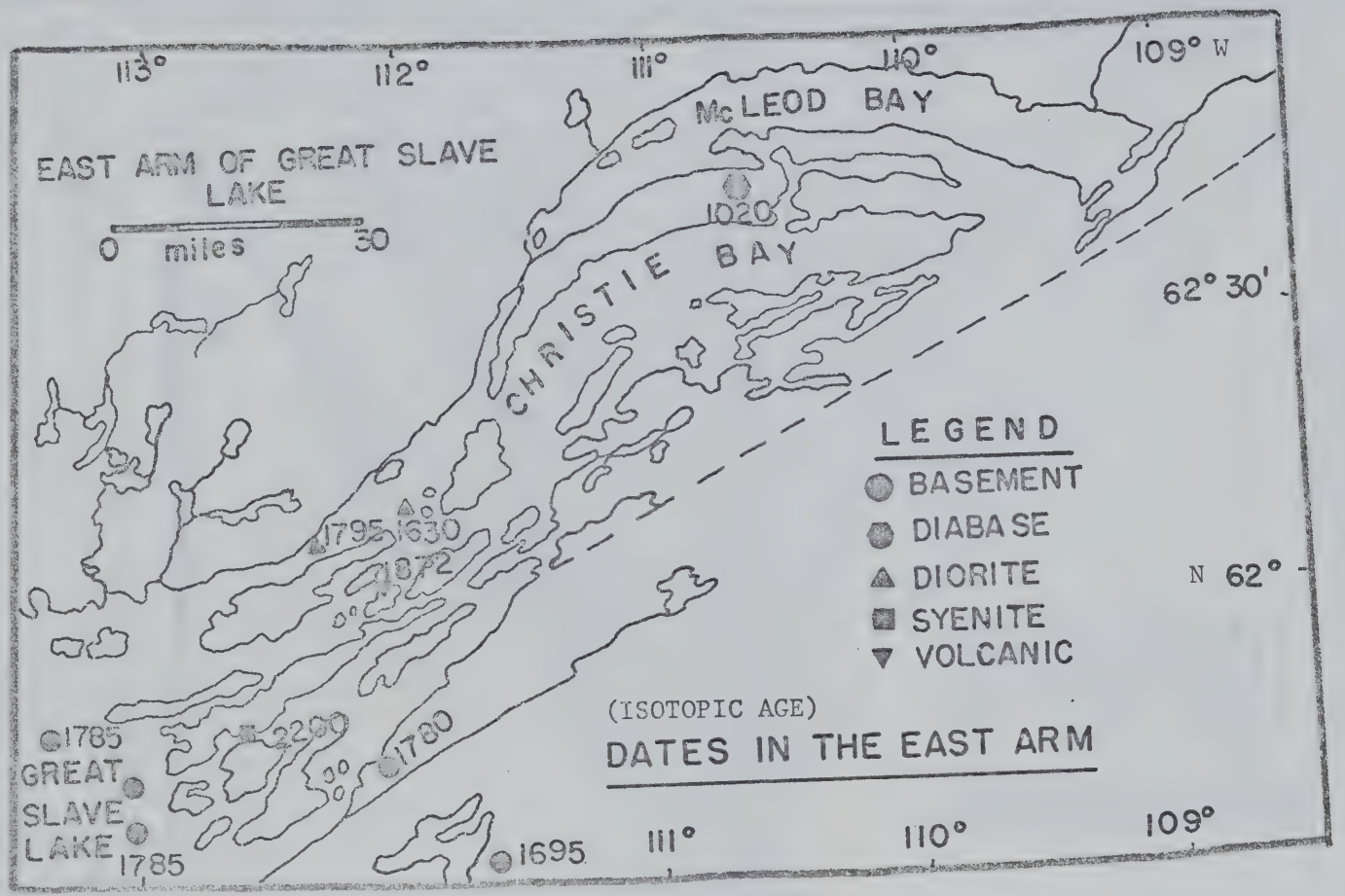

FIGURE 3

Sources of Data: Fahrig and Wanless(1963), Wanless et al (1970) and Baadsgaard et al (1973).

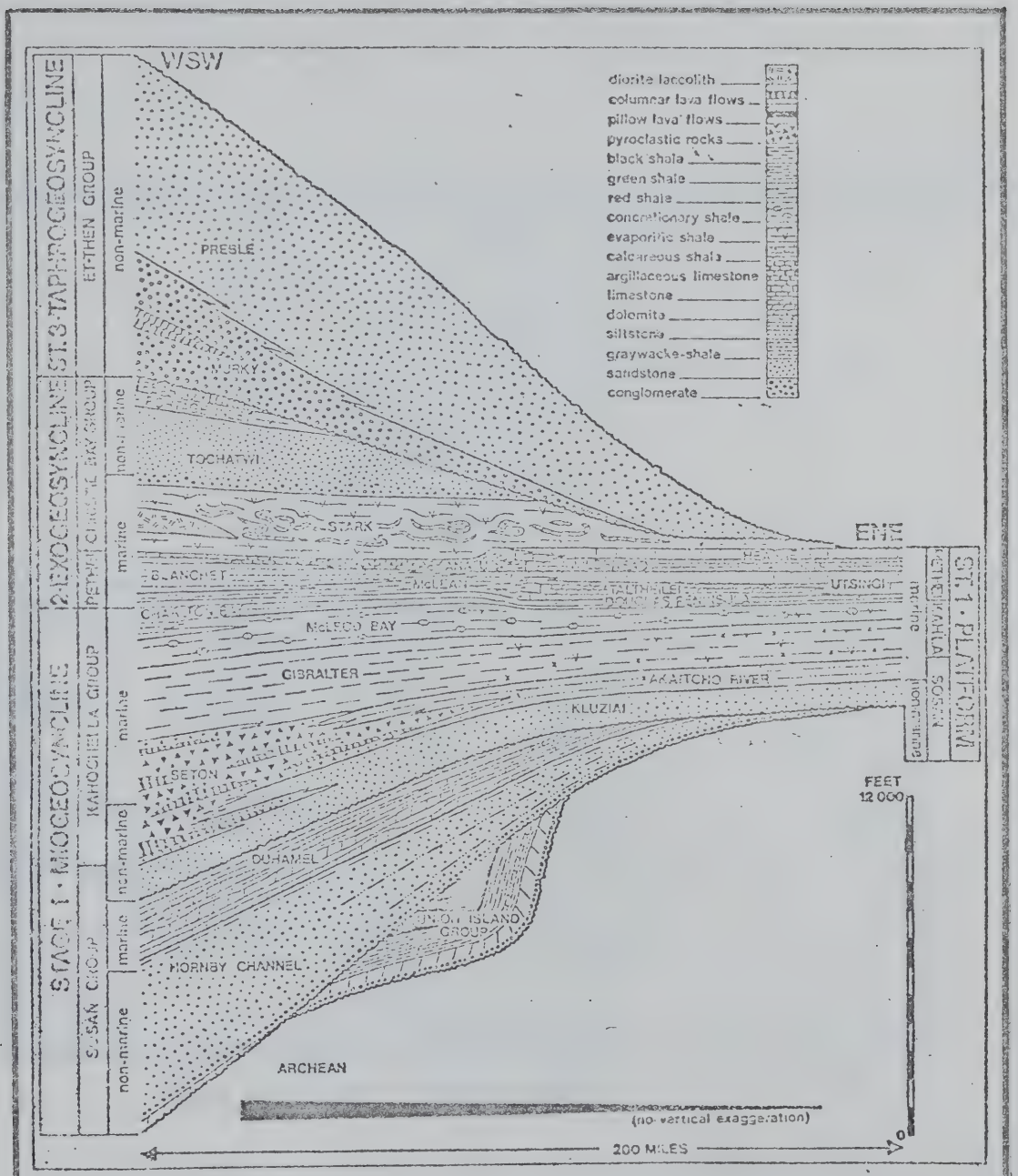

FIG. 4 Stratigraphic cross-section of Proterozoic formations from the northeast to the southwest end of the East Arm Fold Belt.

(after HOFFMAN, 1968)

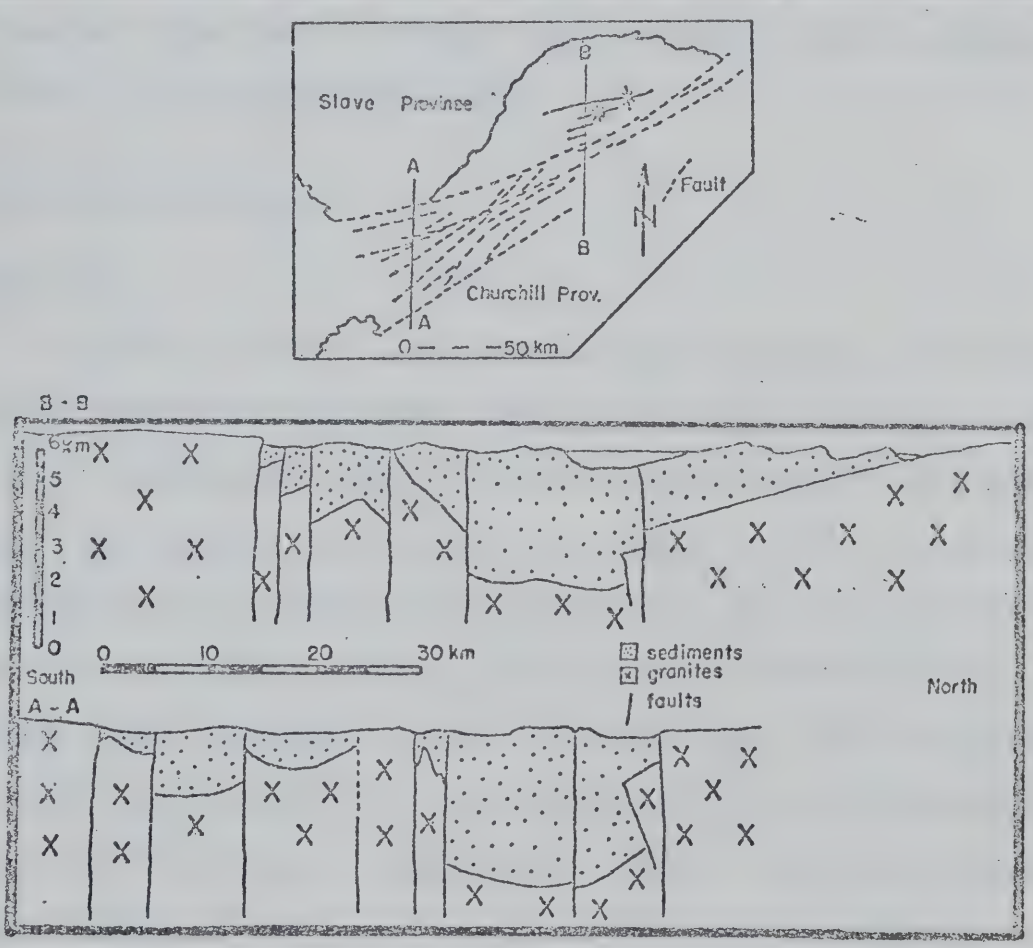

FIGURE 5 FAULT STRUCTURES

(after HOFFMAN, unpublished-1)

CHAPTER THREE

BLANCHET ISLAND: STRUCTURE AND STRATIGRAPHY

General Statement

To successfully discuss the mine area, the regional structure of Blanchet Island must be studied, since it appears that the mineralization is structurally controlled.

Stratigraphy and Age

The Sill

Bodies of massive "quartz diorite" occur in contact with rocks of the Great Slave Supergroup along a nearly linear belt from Meridian Lake to the Caribou Islands - nearly the entire length of the East Arm. They usually intrude the Pethei Group or the Stark Formation. Remarkably, these bodies have created a great deal of controversy among the geologists working in the East Arm. STOCKWELL (1936), BROWN (1950), and WRIGHT (1951), to mention just a few of the earlier workers, all concluded that these bodies intruded the formations of the Great Slave Group. BARNES (1952), however, concluded the opposite; he stated "the quartz diorite is older than the great Slave Group, and is separated from it by a regolith of decomposed granitic material." He hypothesized that the bodies are basement horsts, emplaced during the deposition of the Pethei Formation which he interpreted to overlie the bodies unconformably and to contain detritus eroded from them.

Careful examination of the contact relations along the south shore of Blanchet Island, along the north and south shores of the

Caribou Islands, and in the Regina Bay area proves that the bodies are sills which intrude the Pethei Group and, in some cases, the Stark Formation of the Christie Bay Group.

Several relations arising out of this study disprove the hypothesis outlined by BARNES (1952).

I. Contact metamorphism is not extensive, but contrary to Barnes' interpretation, the limestone beds contain calc-silicate minerals of metamorphic origin near the contact.

II. In most outcrops on Blanchet Island, the contact conforms with the bedding in the Pethei Group, but top determinations and the well-established stratigraphic sequence of formations in the Pethei Group prove that the quartz diorite overlies the sedimentary strata. The contact is thus the bottom surface of a sill or laccolith (HOFFMAN, 1968).

III. Where the contact was carefully mapped on the southeast side of Blanchet Island, the quartz diorite was found to be discordant with the sedimentary strata. At the east end of the body, about 50 feet of Stark Formation is present beneath the contact, whereas to the north and south, away from the synclinal axis in the sedimentary beds, the quartz diorite is in direct contact with the Pekanatui Point Formation of the Pethei Group (HOFFMAN, 1968).

IV. The quartz diorite is dissimilar compositionally, texturally and in age from the Archean rocks along the north shore of the East Arm and on Simpson Island.

V. The Blanchet Formation contains greywacke sandstones that BARNES (1952) thought to be derived from the unroofing and erosion of the quartz diorite bodies, but are now known to be deep water turbidites

derived from the west (HOFFMAN, 1968).

It has already been mentioned that K-Ar dates on these "quartz diorite" sills have revealed ages of 1785, 1795, and 1845 million years, (Figure 3). This would place a minimum age on the Pethei Group. The bodies were probably emplaced prior to the deposition of the three upper formations of the Christie Bay Group. Indeed, it will be shown later that the emplacement of the bodies was possibly responsible for generating the gravity slide breccias of the Stark Formation. The observation of STOCKWELL (1932) that some of the Stark Formation breccias contain blocks of 'syenite' is important in this regard. If the 'syenite' blocks are derived from the same quartz diorite bodies, emplacement and unroofing of the quartz diorite during the deposition of the Stark Formation is an unavoidable conclusion (HOFFMAN, 1968).

Formations Involved in the Blanchet Island Area (MAP 2)

The formation descriptions mentioned below are for the most part by HOFFMAN (1968). They are applicable to Blanchet Island which contains both platform and basinal types of sediments.

Seton Formation

The oldest group of rocks exposed in the area is that of the Seton Formation. This group of volcanic rocks and pyroclastics which occur in the upper part of the Lower Aphebian sequency constitute a principal phase of Proterozoic volcanism in the East Arm. Earlier described as 'greenstones' or basalts, and recently as an andesite-rhyolite suite, the Seton volcanics are now proven to possess a spilitic-keratophyric affinity (OLADE, 1972). Associated with the

Seton alkali volcanism are hypabyssal intrusions of albite granophyre and subvolcanic quartz feldspar porphyries, (OLADE, 1972).

OLADE (1972) suggests that the Aphebian Coronation Geosyncline during Seton times was characterized by partially submarine effusive volcanism associated with a small volcanic island complex. Also, there is apparent contemporaneity between the Seton volcanism in the southwest of the basin and shallow marine deposition of the upper members of the Sosan Group.

The Seton Formation nicely satisfies the alkali volcanism criterion for Hoffman's aulacogen theory.

Gibralter Formation

This unit conformably overlies the Seton Formation on islands just south of Blanchet Island. The dominant lithology of the Gibralter Formation is red shale. The shale contains thin lenses of pale yellow or greenish calcareous shale. Minor thin beds of quartz pebble conglomerate or red siltstone occur near the base of the formation. The upper parts of the formation are characterized by beds of granular hematite, intraformational conglomerate, hematite-calcite stromatolites, and crystal casts after gypsum, (HOFFMAN, 1968). It is believed these shales originated in a shallow water, perhaps littoral, marine environment, (HOFFMAN, 1968).

McLeod Bay Formation

The McLeod Bay Formation overlies the Gibralter Formation conformably. It is composed of red shale with closely spaced calcareous concretions. The concretions are arranged in rows parallel to bedding. Bowing of the shale laminations around the concretions

is ubiquitous. Lenses of 'out of place' concretions also occur. A shallow water, marine origin is favoured, (HOFFMAN, 1968).

Charlton Bay Formation

The Charlton Bay Formation conformably overlies the McLeod Bay Formation from which it is distinguished by its green color, greater resistance to weathering, lesser fissility, and much more widely spaced, larger concretions. Therefore, the formation consists of very finely laminated, dark green shale with large, widely spaced, oblate spheroidal, brown weathering, calcareous concretions. Smaller pyrite or marcasite nodules are also found and irregular patches of jasper occur within some of the concretions. Its dark green color and the presence of turbidite beds suggests deposition in deeper water than the underlying red shales, (HOFFMAN, 1968).

It outcrops on the south shore of Blanchet Island as well as on some of the islands to the south.

Douglas Peninsula Formation

The Douglas Peninsula Formation is conformably overlain by the McLean Formation where it outcrops on Blanchet Island. Normally it is overlain by the Taltheilei Formation or the Utsingi Formation. This stratigraphic irregularity indicates that we are on the south side of the East Arm synclinorium where quite commonly the Taltheilei and Utsingi Formations are absent.

The formation is lithogically homogeneous, consisting of thin-bedded, fissile, red marlstone. The marlstone consists of ragged lenticles of pink to light brown argillaceous limestone, embedded in dark red-brown mudstone.

Although lithologically similar to many non-marine calcareous rocks, the presence of gypsum casts in this formation indicates at least local high salinity, (HOFFMAN, 1968).

Taltheilei Formation

The Taltheilei Formation outcrops on the north shore of the north part of the island.

The formation consists predominantly of light brown weathering, thin to thick-bedded, fine to medium grained crystalline dolomite with minor limestone. Two major facies associations occur. The first, which characterizes most of the type section, consists of interbedded stromatolitic, laminated and massive dolomite. In the second major facies association, the stromatolites occur in mounds or bioherm-like assemblages rather than in continuous beds. Stromatolite mounds about twenty feet across occur near the base of the type section, but far more impressive mounds of fifty to 150 feet across and sixty feet thick occur on Blanchet Island.

The Taltheilei Formation is of shallow water marine origin. The first facies assemblage is characteristic of back-reef lagoonal deposition with accumulation occurring predominantly in the intertidal zone. The stromatolite mounds of the second facies assemblage are analogous to the organic reefs of younger rocks. The tops of the mounds probably protruded into the littoral zone, but the clastic beds accumulating at the base of the mounds may have been permanently submerged and subject to nearly continuous sediment movement, conditions which did not allow the sediment surface to be stabilized by algal mats, (HOFFMAN, 1968).

Utsingi Formation

The Utsingi Formation outcrops only on the northeastern part of Blanchet Island; it overlies the Taltheilei Formation.

The formation consists of two members. The lower, and thicker member consists of a monotonous succession of thick-bedded, blue-grey weathering, crystalline limestone with distinctive discontinuous laminations and mottling of brown weathering dolomite. The upper member consists of massively bedded white limestone. The limestone contains closely spaced and highly crenulated siliceous or dolmitic laminations.

Although a supratidal origin is favoured, a major difficulty with any interpretation of the Utsingi Formation is to explain its remarkable thickness and uniformity, (HOFFMAN, 1968).

McLean Formation

The McLean Formation outcrops at several places on Blanchet Island and appears to be deeply involved with the folding along the sill-sediment contact. The McLean Formation overlies the Douglas Peninsula Formation conformably. The lower part of the formation consists of medium to thin bedded grey limestone with closely spaced, one centimeter thick, ragged and crenulated, discontinuous laminations of red brown mudstone. The upper part of the formation consists of brown to green mudstone with flat bottomed, convex-upward nodules of argillaceous limestone three to five centimeters across, (HOFFMAN, 1968).

The McLean Formation is considered to be of marine origin, and its upper part is thought to have been deposited in deeper water than

the correlative Utsingi Formation, (HOFFMAN, 1968).

Blanchet Formation

Although not indicated on the map, the Blanchet Formation does outcrop on the south part of Blanchet Island. It overlies the McLean Formation and underlies the Pekanatui Point Formation.

The most conspicuous lithology of the Blanchet Formation is greywacke sandstone in closely spaced, parallel-sided, graded beds less than 1.5 feet thick. The greywacke beds are separated by thin beds of argillite or interlaminated argillite-limestone. The greywackes consist of 35 percent very angular quartz grains, 15 percent rock fragments, 20 percent feldspar and 30 percent fine grained chloritic matrix. The rock fragments are mainly sedimentary, volcanic, and low grade metamorphic types. Interbedded with the greywacke are units of argillite up to 75 feet thick with nodules of argillaceous limestone and very thin, evenly bedded limestone with argillite partings.

The rhythmic alterations of parallel-sided greywacke and argillite, the graded bedding, and the lack of crossbedding, cut-and-fill, or mudcracks indicate deposition from turbidity currents.

Pekanatui Point Formation

This formation is generally folded and is often mineralized. In most localities on Blanchet Island, it is overlain by the sill. The Pekanatui Formation is composed of three major lithologies of which the most abundant and striking is very thin, evenly bedded, light grey aphanitic limestone. The limestone beds are mostly one to five centimeters thick and are separated by paper-thin siliceous

seams or by argillite laminations less than one centimeter thick. Two outstanding features of these beds are convolute bedding and breccia beds. The angular fragments in the breccia beds range in size from two centimeters to blocks up to fifteen feet or more across. The size of the fragments in any one bed is remarkably uniform and the smaller fragments are all composed of lithologies similar to the surrounding beds. The two other lithologies of the formation are dark grey argillites or argillaceous dolomite with nodules of limestone and greywacke beds, (HOFFMAN, 1968).

This unit is well-exposed on the western part of the island but rather quickly disappears from the stratigraphic column on the eastern end of the island. One may therefore cross from a terrigenous basinal sequence in the west to a platform sequence in the east.

The aphanitic limestone, their very thin and even bedding, and the lack of desiccation and stromatolitic structures suggest deep water deposition. The presence of turbidite greywackes supports this interpretation, (HOFFMAN, 1968).

Wildbread Formation

This formation outcrops on the northeastern part of the island. It overlies the Utsingi Formation (the Pekanatui Point and McLean Formations are missing) and underlies the Hearne Formation.

The formation contains two major facies associations. The top of the formation is marked by a 50 foot thick branching columnar stromatolite bed. Below this bed, three facies are interbedded. These are:

1. white, commonly recrystallized, ripple-marked, thin bedded, oolitic limestone,
2. well-laminated, grey limestone and brown weathering dolomite with stromatolites of the laterally linked type, oncolites and edgewise congolmerate,
3. thick bedded white to grey limestone.

The scattered exposures on the south limb of the synclinorium belong to the second facies association. Where undolomitized, the rocks are composed of stromatolitic mounds, bioherm-like structures generally less than 15 feet across. The mounds are surrounded by crudely bedded calcirudite, in which most of the limestone fragments were derived from the stromatolite mounds, (HOFFMAN, 1968).

The first facies association is a typical back reef lagoonal succession. The stromatolitic mounds of the second facies association are analogous to the reefs of younger carbonate complexes. The coarse clastic carbonate sediments which surround the mounds were deposited in the high energy inter-reef environment, (HOFFMAN, 1968).

Hearne Formation

The Hearne Formation occupies the south shore of the north-eastern part of the island and also outcrops on some of the islands south of Blanchet. It conformably overlies the Wildbread Formation.

The predominant lithology is thick bedded, white to light grey limestone with laminations and mottling of reddish limestone or dolomite.

A back-reef lagoonal origin for the Hearne Formation is probable.

The lack of stromatolites suggests a permanently submerged rather than intertidal site of deposition, (HOFFMAN, 1968).

Stark Formation

The Stark Formation consists predominantly of red, silty, terrigenous mudstone. The mudstone is commonly fractured and the fracture planes are coated with specularite. Lenticular patches parallel to bedding are pale yellowish green.

Three main types of breccias form an important component of the Stark Formation. The first type consists of scattered angular to sub-rounded fragments of various dolomite and limestone lithologies widely scattered in a matrix of red mudstone. These breccias are thick and show little stratification. The second type consists of angular blocks of carbonate of uniform lithology in a matrix of mudstones and sparry white calcite. The third type consists of large and small angular blocks of a wide variety of Stark Formation lithologies closely packed in a matrix of red mudstone and finely comminuted carbonate detritus, (HOFFMAN, 1968). In this type of breccia, STOCKWELL (1936) reported blocks of 'syenite'.

On the southeastern portion of Blanchet Island, HOFFMAN (1968) reports that the sill unconformably overlies the Stark Formation. This evidence, as well as the breccias, may indicate some structurally controlled deposition in the area. Since this thesis postulates that the deposition of the Stark Formation is synchronous with the structural development of the area, any explanation of its origin is foregone for the moment.

Summary

Briefly, the northeastern part is divided from the southwestern part of Blanchet Island by a lithostratigraphic facies change. The Taltheilei, Utsingi, Wildbread, and Hearne Formations to the north represent a carbonate platform sequence while the McLean, Blanchet, and Pekanatui Point Formations to the south represent a terrigenous basinal sequence. This is better illustrated by HOFFMAN's (1968) cross-section through the East Arm. The Island is represented by the middle portion of this diagram, (Figure 6).

Structure of Blanchet Island

In its broadest sense the structure of Blanchet Island is a northeast trending synclinorium superimposed on a 'macro graben'. The "graben" is approximately two miles wide and 16 miles long. Later, transcurrent wrench fault movement along these normal graben bounding faults moved the capping sill creating a drag fold effect along the contact.

Faults

A northeasterly, near-vertical fault, (thought to extend to great depths), shown on the accompanying diagram (Figure 7), roughly bisects the island. This fault was first hypothesized by STOCKWELL (1936) and later confirmed by HOFFMAN (1968). Two more hypothetical parallel faults are shown as dashed lines. These faults would be similar to the above fault and would form the 'macro graben' beneath the island.

The existence of these faults really becomes apparent when

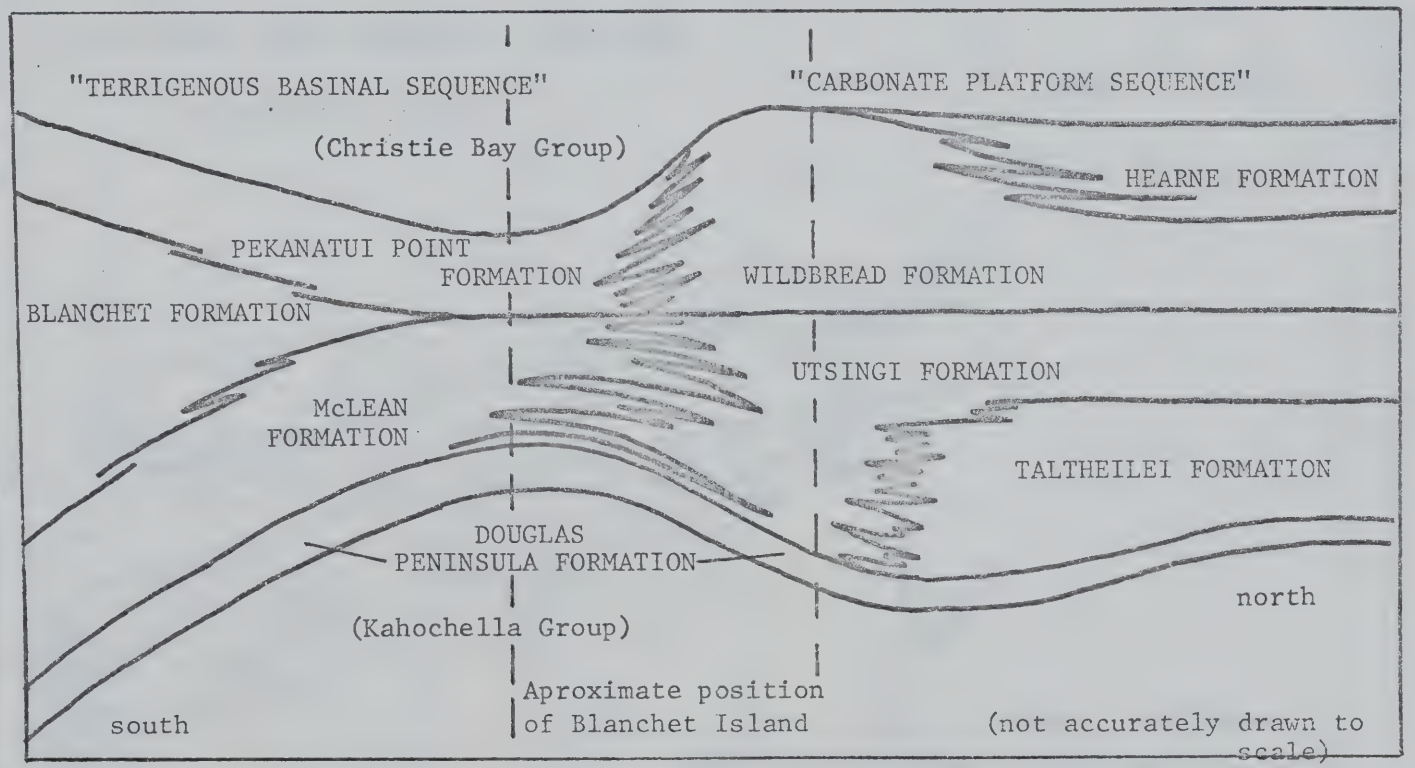

Figure 6: Diagrammatic cross-section showing the stratigraphic relation of formations in the Petei Group. (after HOFFMAN, 1968)

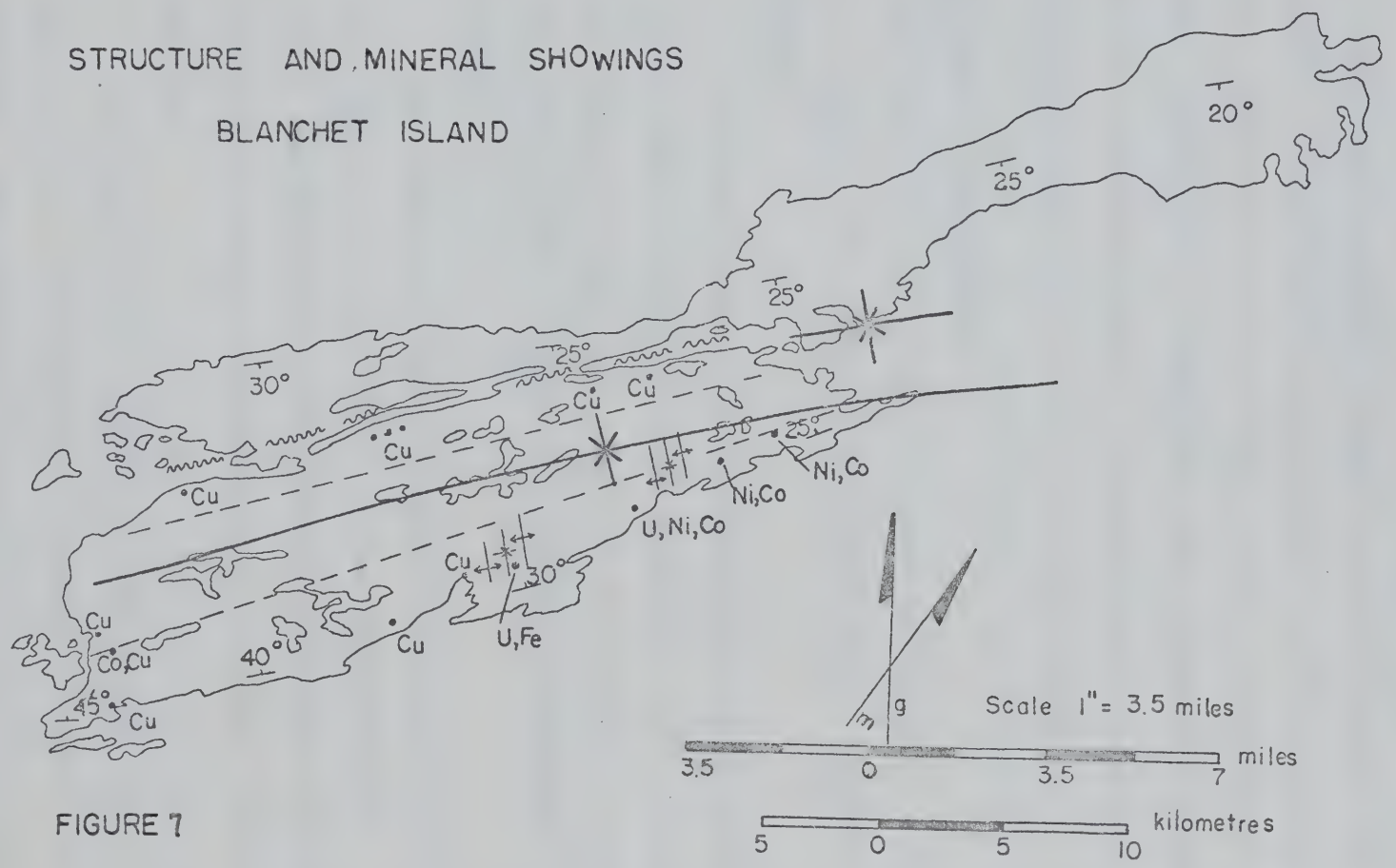
STRUCTURE AND MINERAL SHOWINGS
BLANCHET ISLAND
20°
25°
25°
25°
30°
25°
Cu
Cu
Cu
Cu
Cu
Ni, Co
Ni, Co
U, Ni, Co
30°
Cu
Cu
Co, Cu
40°
Cu
U, Fe
45°
Cu
m
g
Scale 1" = 3.5 miles
3.5
0
3.5
7
miles
5
0
5
10
kilometres

FIGURE 7

cross-sections are drawn through the island, (Figure 8). It is found that the Stark Formation outcrops at both the western and eastern ends of Blanchet Island. HOFFMAN (1968) reports that the sill in this area discordantly overlies the Stark Formation and yet elsewhere the sill concordantly overlies the Pethei Formation. One might conclude that the sill is in reality a lopolith with discordant contacts, but its small size and conformability elsewhere leaves this conclusion in doubt. A better explanation for the concordant/discordant effect is that of a graben origin.

Graben Origin of Some Features

The origin of the concordant/discordant effect can be accounted for in four stages shown on the accompanying diagram. (Figure 9)

I. Stage I

This stage involves the relatively undisturbed deposition of the Pekanatui Point and McLean Formations. The stratigraphic descriptions of these units show that they consist of undisturbed deep water sediments deposited in a basinal environment.

II. Stage II

This stage shows the development of a graben, probably synchronous with the deposition of the Stark Formation. Perhaps the down-moving graben block is responsible for some of the slide breccias characteristic of the Stark Formation.

III. Stage III

This stage involves compression of the graben block, probably before the deposition of the Stark Formation was complete. Compressions of this nature are well-documented in the East Arm by HOFFMAN (in press-1). This force would

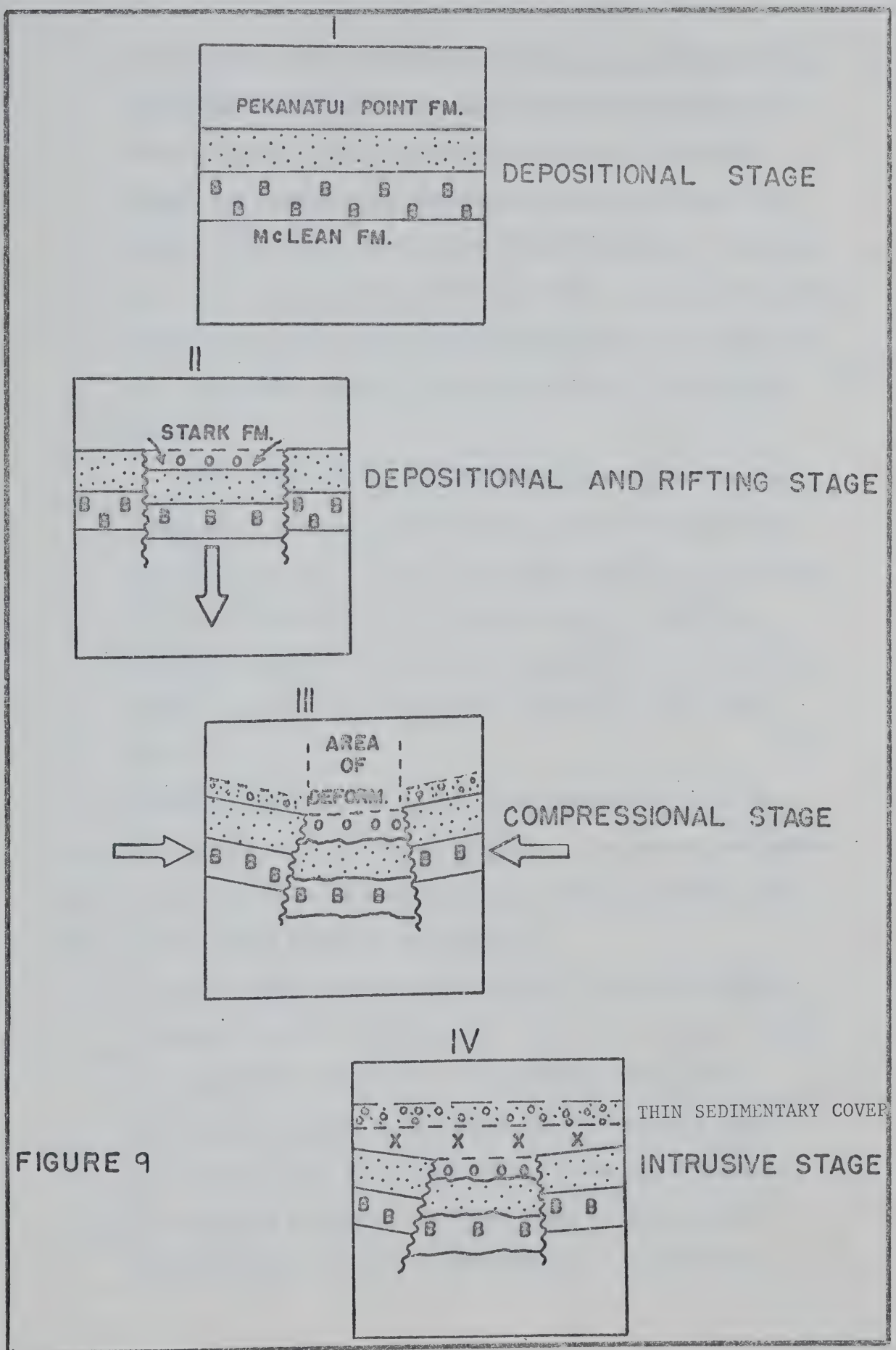
I
PEKANATUI POINT FM.
McLEAN FM.
DEPOSITIONAL STAGE
II
STARK FM.
DEPOSITIONAL AND RIFTING STAGE
III
AREA OF DEFORM.
COMPRESSIONAL STAGE
IV
THIN SEDIMENTARY COVER
INTRUSIVE STAGE

FIGURE 9

fit in nicely with the compressive stage involved with the aulacogen as a whole. This compressive stage would account for the superimposed synclinorium evidence on Blanchet Island and finally, the compression would account for the intense deformation seen in the Stark Formation at the south-east end of the island by HOFFMAN (1968). Indeed, the intense deformation in the Stark Formation could give the impression of a discordant contact between the sill and the sediment.

IV. Stage IV

This stage was the concluding stage and involves the intrusion of the sill, probably via one of the three major faults in the area. The sill intruded within the Stark Formation or between the Stark Formation and the overlying Tochatwi Formation. There is no evidence of this overlying sediment today. It is suspected it would be a very thin cover.

STOCKWELL (1936) claims to have seen pieces of syenite in some of the breccias of the Stark Formation. An obvious conclusion would be that the sill intruded within the Stark Formation, but there are two other possible explanations.

1. It is becoming more and more apparent that some syenitic bodies in the East Arm are older than others (Easter Island, see figure 3). Therefore, local erosion along sill or dyke-induced ridges in the basin may have exposed these to provide blocks of syenite during Stark sedimentation.
2. The syenitic blocks in the Stark might be from shallow dykes associated with the underlying sill on Blanchet

Island or another laccolith of the same age (Caribou Island) which uplifted its cover to shed breccias into adjacent local basins. The uplift and partial unroofing during Stark time would give almost contemporaneous intrusion and breccia deposition, with very limited time lag.

Folds

The island consists of northeast trending anticlines and synclines. The southern half of the island consists of the aforementioned synclinorium superimposed on a graben. Figure 7 shows some of the more prominent folds making up the island. The dips and strikes shown on the diagram represent an average for those taken in the area. Generally, the sediments dip about 20° to 30° under the sill. The smaller folds shown are representative of the small synclinal and anticlinal folding that involved both the sediments and the sill along the contact. The origin of these folds can be explained by the graben model. After sedimentation ceased and the sill was intruded, the area could have undergone a lateral, transcurrent movement along the normal faults bounding the graben. This would in effect move the sill over the underlying sediments resulting in drag folds along the contact. Not enough data is available to detect whether or not later faulting was 'left lateral' or 'right lateral'.

The mine area occupies one of these smaller folds. The smaller folds apparently have created an undiscernable amount of minor faulting. The bedding data collected in the mine area indicates possible cylindrical folding. The folds plunge under the sill at approximately 20° in a northeasterly direction. Some of the sharper

anticlines in this series have characteristic breccias at the apex and a boudinage effect in the synclines. The folds seem to die out very quickly at depth. (Figure 10)

Conclusions

In conclusion, the 1800 million year old sill overlies the Pekanatui Point Formation concordantly and the Stark Formation discordantly. The latter contact is possibly graben derived.

The stratigraphy of the area indicates there is a litho-stratigraphic facies change, separating the carbonate platform sequence of northeastern Blanchet Island from the terrigenous basinal sequence found in the southern part of the island.

Finally, it seems that Blanchet Island consists of a north-east trending synclinorium superimposed on a graben with later transcurrent wrench faulting causing drag folds along the sill-sediment contact.

CHAPTER FOUR

MINERALOGY OF THE SKARNS

Introduction

This chapter describes the metallic and non-metallic constituent minerals of the 'skarns' associated with the intrusion of the diorite-syenite sill on Blanchet Island. The area to be described is on the Lux Group of claims, near the main mine site. These descriptions, as well as the textural relationships, arise from a study of eight polished sections and five associated thin sections, (Table II).

The skarn mineralization may be divided into two types, a magnetite-hematite-hornblende hornfels and a chlorite-epidote-hematite-magnetite type. The chapter will deal with the two types separately.

Magnetite-Hematite-Hornblende Hornfels

Opaque Minerals

A. Hematite (α Fe_2O_3)

In some cases it is shown that there are two distinct stages of hematite. The first stage consists of anhedral crystals often with magnetite martitization, while the second stage is characterized by flamboyant, radial, euhedral crystals of hematite. The second stage can cross-cut the first stage as well as many of the gangue minerals. A third less common stage occurs with magnetite crystals coated with hematite reaction rims.

TABLE II

Skarn Mineralization

Polished Sections	Common Minerals	Thin Sections	Common Minerals
E-14-73-7	Magnetite/Hematite Martitization	E-14-73-7	Hb.(85%), Plag.(And.)(10%), Carb. veining + trem. act.
E-12-73-4A	Magnetite/Hematite/ Pyrite/Chalcopyrite	E-12-73-4A	Hb.(90%), Apatite, Plag., Carb. veining
E-11-73-4A	Hematite	E-11-73-4A	Chl., Epi., Apatite, Plag., Carbonate.
B.I.3.71	Hematite/Magnetite	B.I.3.71	Hb., Epi., Apatite, Plag., Carbonate.
E-11-73-5	Hematite/Magnetite	E-11-73-5	Chl., Cal., Apatite, K-fsp., Plag.
B.I.22.71	Magnetite/Hematite/ Chalcopyrite		
B.I.5.71	Hematite/Magnetite Martitization		
E-14.73-12	Hematite/Magnetite		

Hb.=Hornblende, Plag.=Plagioclase usually Andesine, Carb.= Carbonate, trem.= Tremolite, act.= Actinolite, Chl.= Chlorite, Epi.= Epidote, Cal.= Calcite, K-fsp.= K feldspar.

B. Magnetite (Fe_3O_4)

Magnetite usually occurs in two distinct habits but whether these represent two distinct generations is uncertain. The first type is magnetite martitization of the hematite with magnetite occurring as minute blebs within the massive hematite. This stage would coincide with the anhedral first stage of the hematite. In the second type, magnetite may itself appear as anhedral crystals or even as euhedral crystals. Often this stage has reaction rims with hematite replacement or is cross-cut by bladed 'flamboyant'[1] hematite crystals.

C. Pyrite (FeS_2)

Pyrite was found in only one of the polished sections. The pyrite appears to cross-cut magnetite crystals of the anhedral type and therefore appears to be later than one of the hematite stages and later than one of the magnetite stages, but is probably earlier than the 'flamboyant' hematite and the reaction rim type of hematite.

D. ($CuFeS_2$)

As with pyrite, chalcopyrite was only found in one of the polished sections. Its textural relationships indicate that it was either synchronous with or later than the pyrite. It definitely cross-cuts the pyrite, but it is not certain whether or not it replaces the pyrite.

1. radial aggregates of hematite, see picture 1, plate 1.

Transparent Minerals

A. Carbonates

The present study indicated at least two and possibly more generations of carbonate. The carbonate is mainly calcite. Primarily, the carbonate minerals make up a matrix in which the opaques, as well as some of the transparent minerals, have grown. This is the first stage. The second stage consists of carbonate veins which cross-cut all minerals, often forming micro breccias. The third stage is not present in all samples. It again consists of carbonate veins cutting all the minerals but it also cuts some of the previous carbonate veins.

B. Hornblende

The hornblende in this type of skarn often makes up eighty to ninety percent of the samples. It is a very pleochroic iron-rich member of the amphibole series, probably ferrohastingsite because of its dark blue green color. This amphibole is cut by the metallic minerals as well as the carbonate veins. The hornblende appears to surround the plagioclase feldspars.

C. Plagioclase-Andesine

The plagioclase usually makes up ten modal percent of these rocks. It is often altered to kaolinite. The majority of the plagioclase in these rocks is andesine. Its crystals are often surrounded by hornblende. It is earlier than metallic minerals, earlier than carbonate veining and synchronous with or earlier than hornblende.

D. Apatite

Apatite occurs consistently in minor amounts throughout these samples. It occurs as small crystals throughout the feldspar matrix.

E. Tremolite-Actinolite

Tremolite-actinolite veining occurs in association with the first phase of carbonate veining. The nature and size of the veining precluded accurate optical identification. The veins cross-cut the non-metallic phases.

Conclusion

The paragenetic sequence of the hornblende hornfels skarns is shown on Table III. This type of skarn probably represents the metamorphism of a calcareous argillite bed occurring in a limestone unit. Upon intrusion of the sill, calcium, iron, and sulphur-rich solutions were introduced into this bed forming the minerals hornblende, plagioclase, apatite and calcite by normal metamorphic-metasomatic reactions. Later, these iron-rich solutions precipitated magnetite and hematite. During Stage III, the availability of oxygen was critical and this accounts for the formation of pyrite and chalcopyrite. As the intrusion cooled and new solutions were introduced, 'flamboyant' hematite precipitated as well-formed crystals. All these events were periodically disturbed by carbonate and tremolite-actinolite veining.

TABLE III

Paragenetic Sequence of the Hornblende Hornfels Skarn

Stage	I	II	III	IV
Hematite		———	——	—— ——
Magnetite		—— --	——	
Pyrite			——	
Chalcopyrite			—— --	
Calcite	——		——	——
Hornblende	——			
Plagioclase	——			
Apatite	——			
Tremolite-Actinolite				——

Hematite-Magnetite-Chlorite-Epidote Skarn

Opaque Minerals

A. Hematite

This type of skarn shows a prevalence of hematite over magnetite. Two phases have been identified. The first and most obvious stage is that of 'flamboyant' hematite. This radial growth cross-cuts all gangue minerals. A second, less distinct stage is that of hematite replacing magnetite in a 'reaction rim'.

B. Magnetite

There is only one stage of magnetite and it is earlier than either of the two hematite stages. Sometimes, the magnetite occurs as distinct crystals but usually it is being replaced by hematite.

C. Chalcopyrite and Pyrite

These two minerals occasionally occur as very small crystals in the matrix. They formed before the flamboyant hematite and after the formation of magnetite.

Transparent Minerals

A. Chlorite (Prochlorite and Clinochlore)

The samples appear to contain two stages of chlorite. One stage occurs very early, before the hematite stages; and the second state is clinochlore replacement of some of the feldspars. The samples are banded with rhythmic bands of chlorite which are tightly folded.

B. Calcite

The samples contain at least two stages of calcite. One stage is very early; that is, calcite crystals occurring in the matrix. The second stage involves calcite veining which cross-cuts all other stages. This latter stage is later than the flamboyant hematite.

C. Apatite

Apatite occurs as minute, often euhedral crystals dispersed in the matrix.

D. Plagioclase

The samples also contain andesine plagioclase in the matrix. This mineral makes up approximately thirty to forty modal percent of the specimens.

Conclusion

Table IV shows the paragenetic sequence for the hematite-magnetite-chlorite-epidote type of skarn.

TABLE IV

Paragenetic Sequence of the Hematite-Magnetite-Epidote Skarn

Stage	I	II	III	IV
Hematite				
Magnetite				
Chalcopyrite				
Pyrite				
Chlorite				
Calcite				
Apatite				
Plagioclase				
Epidote				

CHAPTER FIVE

MINERALOGY OF THE ORE BODY

Introduction

This chapter describes the metallic and non-metallic constituent minerals of the ore body on the Lux Group of claims (Blanchet Island, N.W.T.). These descriptions, as well as the textural relationships, arise from a microscopic study of 31 polished sections.

Of these 31 sections, 16 representative samples were etched in concentrated nitric acid with five second immersion. This etching technique revealed the difference between safflorite and rammelsbergite, with the latter being deeply etched and the former left untouched. These sections and their mineral sequences are shown in the accompanying table, (Table VI).

Opaque Minerals

Niccolite (NiAs)

There appear to be four distinct types of niccolite in the deposit. Type one is anhedral or massive and generally shows replacement by rammelsbergite. Type two is banded and is often wholly replaced by rammelsbergite. A further type may be described as pisolitic; that is, a niccolite core completely surrounded by rims of rammelsbergite or safflorite, or both. A fourth and final type consists of unoriented blebs of niccolite in rammelsbergite. These blebs may represent the last remnants of unreplaced niccolite. These four types of niccolite occurrence may represent different

TABLE VI

Table of Ore Minerals - Etched Samples Only

Sample	Descriptive Minerals-Sequence
B.I.33.71	Saf/Ram/Nic/(two carb. phases)
B.I.30.71	Cal/Ram/Cal
B.I.18.71(2)	Ram - Saf intergrowth
B.I.16.71(2)	Cal/Saf/Ram/Saf/Nic/Cal
B.I.15.71(2)	Cal/Saf/Ram/Saf/Ram/Cal
B.I.8.71	Cal/Saf/Ram/Nic/Cal
B.I.33.71	Cal/Ram/Cal/Saf/Ram/Nic/Cal
B.I.31.71	Cal/Ram/Saf/Nic/Cal
B.I.26.71	Cal/Saf/Ram/Nic/Cal
B.I.19.71	Cal/Saf-Silver/Cal
B.I.1.71	Cal/ Cal/Saf/Ram/Saf/Ram/Cal
5.73	Cal/Saf/Ram/Nic/Cal
1.73	Cal/Ram-Saf/Nic/Cal
B.I.15.71	Cal/Saf/Ram/Ram/Cal
B.I.1.71	Cal/Saf/Ram/Saf/Ram/Cal
2.73	Cal/Saf/Ram/Saf/Ram/Nic/Cal

Cal= calcite
Saf= safflorite
Nic= niccolite
Ram= rammelsbergite
/ = after

phases of niccolite formation but this is hardly likely, for the following reason. From the table, it can be seen that in all cases, niccolite, along with calcite were the first minerals to crystallize. These types of occurrences would therefore indicate different stages of replacement by later minerals rather than different phases.

Rammelsbergite [(Ni, Co, Fe) As_2]

In the ore deposit, rammelsbergite appears in close association with niccolite. In all cases except one, rammelsbergite is the phase surrounding niccolite. Most of the samples contain two stages of rammelsbergite, but a limited number contain three stages. The first stage involves primary precipitation along with niccolite. The second stage is replacement of niccolite by rammelsbergite, occurring after the first phase and perhaps synchronous with the third stage. This third stage involves concentric growth of new rammelsbergite onto old, often replacing calcite. The second and third stages are typified by small anhedral crystals of rammelsbergite growing onto larger oriented crystals of the first stage.

There is a rare, possibly fourth stage of precipitation represented by parallel bands of rammelsbergite in niccolite. These may be an indication of replacement.

Safflorite [(Co, Fe) As_2]

Safflorite exists as at least three stages in the ore body. It appears to be in close association with rammelsbergite. In almost all of the specimens, safflorite represents the last stage of metallic deposition. It usually rims rammelsbergite and is

always in contact with the carbonate in this stage. The second stage of safflorite usually occurs within the rammelsbergite, so that a band of rammelsbergite is formed, then a band of safflorite, then a band of rammelsbergite, then a band of safflorite. Contrary to this rule, we do find safflorite in contact with niccolite in one specimen, (Sample 1.73). This last feature may represent a fourth replacement stage of safflorite growth. A third stage of safflorite deposition is represented by massive crystals unassociated with either niccolite or rammelsbergite.

Silver

The third stage of safflorite precipitation is always associated with small blebs of native silver. This silver stage is only found in this environment.

Transparent Minerals

Carbonate (Calcite)

Calcite occurs in at least three stages of the ore body. The first stage is associated with the primary precipitation of niccolite and rammelsbergite. The stage is typified by small crystals of calcite completely enclosed in a niccolite or rammelsbergite matrix. The second stage involves fracturing of the metallic minerals and infiltration of calcite into the cracks. These veins cross-cut all minerals and often contain angular fragments of the host minerals. The third stage is similar to the second, but these veins also cut previous calcite veins. This stage is not present in all samples.

Plate 1

1. Flamboyant (radial aggregates) of hematite.
   plane light; unetched; 64X

2. Dark grey - magnetite (rims of hematite); light grey - chalcopyrite; white - pyrite; chalcopyrite/pyrite/hematite/magnetite.
   plane light; unetched; 64X

3. Rammelsbergite (white) replacing niccolite (grey).
   plane light; unetched, 64X

4. Zonal growth, white - safflorite, dark - rammelsbergite; safflorite/rammelsbergite/safflorite/rammelsbergite.
   crossed nicols; etched; 64X

5. Small inclusions of silver in safflorite;
   semi-crossed nicols; unetched, 64X

6. Star shaped twinning of safflorite.
   crossed nicols; etched; 64X

7. Calcite (grey) cutting niccolite white.
   semi-crossed nicols (note the pillow-like boundary); unetched; 64X

8. Niccolite (grey) replacing rammelsbergite (white); note the anhedral rammelsbergite.
   semi-crossed nicols; unetched; 64X

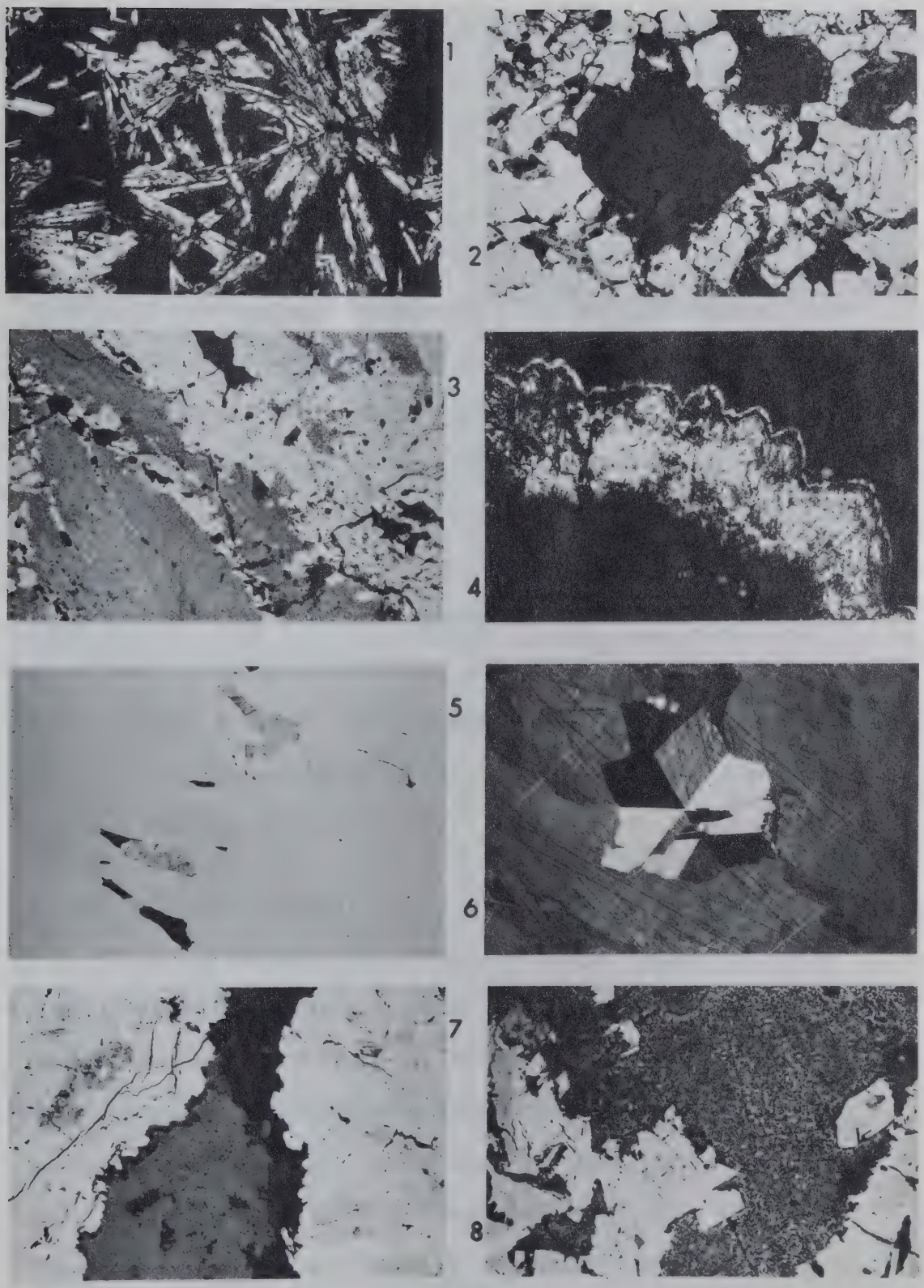

PLATE 1.

Quartz

In most specimens, quartz is found in association with at least the first two stages of carbonate precipitation.

Paragenetic Sequence

The paragenetic sequence for the ore body is shown in Table V. Looking at these stages chemically, a rhythmic sequence of nickel-rich stages alternating with cobalt-rich stages can be seen. This may represent a differential precipitation. For example, as the nickel-rich members (niccolite, rammelsbergite) precipitated, nickel was depleted in the system and cobalt became the dominant member. This would result in the precipitation of cobalt rich minerals. At this point the system could have been refreshed by an influx of new solutions which would be Ni rich and thus once again Ni rich minerals would precipitate. This cycle could repeat itself until the cessation of new solutions. The last minerals to form were cobalt rich.

Source of Mineralization

The first and most obvious source of mineralization would entail hydrothermal leaching of the sill and sediments, with subsequent concentration in the anticlinal fold apex which the ore body occupies. This would imply that the sill, as well as the sediments, would contain appreciable amounts of nickel and cobalt. This does not appear to be the case. Although there are nickel-cobalt showings on the island, the majority of the showings are of the copper type. Therefore, if the sill was rich in nickel and cobalt, it seems logical that the other showings would contain

TABLE V

Paragenetic Sequence of Ore Formation - Blanchet Island

Stage	I	II	III	IV	V	VI	VII
Niccolite	—						
Safflorite	—	—	—		—		
Rammelsbergite	—	—		—			
Calcite	—					—	—
Quartz	—					—	
Silver	—	—	—				

nickel and cobalt. Furthermore, if leaching occurred on a large scale, it is probable that the ore body would contain sulphides. This is not the case, even though the metamorphic rocks surrounding the ore body contain appreciable amounts of sulphides. Indeed, it appears that these sulphide-bearing skarns would be impermeable to hydrothermal solutions due to their fine-grained nature and lack of porosity.

A second possible source for the mineralization is the underlying Seton Volcanics. OLADE (1972) discusses a genetic model which best explains some of the uranium mineralization in the East Arm. He states that, "Uranium and other associated metals already enriched in the volcanics were, during spilitization and diagenesis, leached by connate water in the form of $[UO_2(CO_3)_2]^{2-}$ or $[UO_2(CO_3)_3]^{4-}$ ions and Cu-Co salts. These ions and salts were subsequently transported in downward or laterally-migrating alkaline, carbonate-rich solutions." It would be easy enough to transport these solutions upwards to the overlying Pethei Formation in order to use the model in this area. There is even some uranium mineralization associated with the showings on Blanchet Island, (Figure 7). However, the size of the ore body, the lack of a consistent, uranium-copper-nickel-cobalt mineral assemblage in the showings, and the fact that the ore body contains no sulphides is a disadvantage to this theory as applied to Blanchet Island.

Another source of the mineralization could be from primary solutions originating in the mantle-crust boundary. These solutions could rise along the same channels that the diorite sill used. When the solutions rose to the sill-sediment contact, they migrated

until they came to low-pressure anticlinal crests formed during the folding of the sill and the sediments. In this environment, they were precipitated. This mantle-crust source could explain the numerous nickel-cobalt showings throughout the East Arm. Of course, an anomalous nickel-cobalt rich mantle would have to be postulated originally.

The origin of these nickel-cobalt rich solutions may be projected in the following way.

It can be postulated that the sill represents the intermediate- to acid phase of a magmatic differentiation process. As the sill differentiated from the parent magma, iron, sulphur, and copper would migrate with it. The nickel and cobalt would be locked in the olivines making up the basic differentiate. Later serpentinization of the olivines would release the nickel and cobalt and these solutions would migrate upwards (MASON, 1966, pp. 137-139).

Structural Control for the Ore Body

The sediment-sill contact is folded. The folds vary in size, and they plunge at about twenty degrees under the contact. Figure 10 shows the behaviour of one of these folds as one moves laterally along the contact. It indicates that the folds die out quickly down-plunge. The figure also shows that the ore body is generally on the apex or near the apex of the anticlines. With this evidence, it can be concluded that the mineralization is fold controlled. It should also be noted that the folds in the mine area are very tight or near chevron in nature in contrast with some of the other broader folds. Therefore, the style of folding may also be a controlling factor in ore deposition.

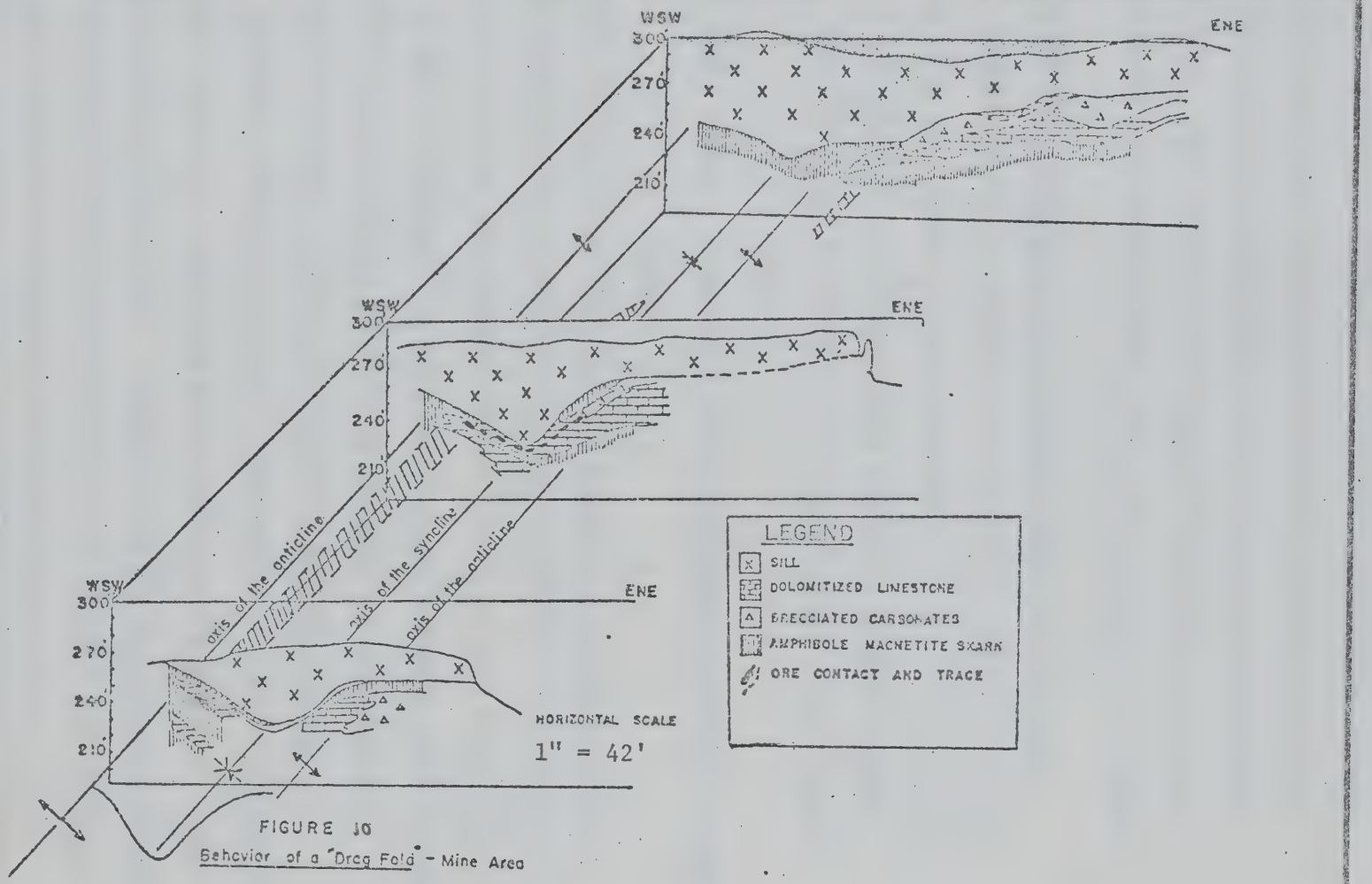

FIGURE 10

Behavior of a "Drag Fold" - Mine Area

The area is typified by a number of small faults. These faults seem to have controlled the amount of metamorphism and metasomatism by allowing differential passage of hydrothermal solutions. They may have had some sort of control on the ore deposition in a similar manner, but this association is unclear.

Metallogenic Comparisons with Analagous Deposits Elsewhere

BADHAM (1973) concluded that the Ni-Co-Ag deposits of the world fall into three distinct age groups:

1. 1700-1400 m.y. Associated with Hudsonian orogenic events,
2. 400- 250 m.y. Associated with Caledonian Hercynian orogenic events,
3. 100- 10 m.y. Associated with Alpine/Andean/Laramide orogenic events.

Secondly, he concluded that the ore deposits are usually part of a polymetallic association that typically includes: Cu, Pb, Zn, S, Bi, Sb, As, U and less commonly Hg, Mo, Sn, W as well as Ni, Co, Fe, As and Ag. Thirdly, he proposes that the deposits are the result of hydrothermal activity around late orogenic calcalkaline to alkaline intrusions in the inner part of continental margins.

Blanchet Island does not fit this framework in every respect. Firstly, the ore is older than most of the world's deposits, being approximately 1800 m.y. old. Secondly, the ore is not polymetallic but atypically contains only Ni, Co, Fe, As and minor Ag. However, Blanchet Island does correlate on the third point; the ore is associated with an alkaline intrusion. Therefore, it is very difficult to compare the ore on Blanchet Island with any other

documented in the literature. Table VIII lists three mines that are comparable in some respects.

TABLE VIII

Comparison of Ni, Co, Fe, As and Ag Deposits[1]

Name and Location	Mineralogy	Associated Intrusion	Age
Blanchet Is. N.W.T.	NiAs, $(Co,Fe)As_2$ $(Ni,Co,Fe)As_2$, Ag	Alkaline Sill	1800 m.y.
Schladming Austria	NiAs, $Ni_{11}As_8$, $(Ni,Co,Fe)As_2$, $(Co,Ni,Fe)As_3$	?	100-10 m.y.
Cusco,Peru	$(Co,Ni,Fe)As_3$	Calcalkaline	100-10 m.y.
Shashani Rhodesia	$NiAs_3$, $NiAs_2$, $(Ni,Co,Fe)As_3$, $(Ni,Co,Fe)As_2$	?	?

[1]Deposits from Ramdohr, 1969.

CHAPTER SIX

PETROLOGY OF THE COUNTRY ROCKS

Introduction

The geology of the mine area is shown on the accompanying map entitled 'Lux Group Mine Area'. Generally, it consists of a dioritic to syenitic sill, concordantly overlying the Pekanatui Point Formation of the Pethei Group. Both the sill and the sediments have undergone later cylindrical folding, which caused brecciation of the anticlinal crests and a boudinage effect in the synclinal troughs. At least two faults cut the area. The area is also typified by numerous fold-controlled joints.

The petrology of the mine area was derived from a study of 150 thin sections. The classification and main minerals of these thin sections are shown in Table VII.

The Sill

This sill is a part of the series of sills and dykes that are arranged in two nearly linear groups along or near the major fault passing through Murky Channel and south of Stark Lake; that is, along an axis of more intense deformation within the aulacogen.

WRIGHT (1951) describes these rocks as reddish, massive, nearly equigranular, and medium to coarse grained. All samples contained some quartz, and they varied in composition from hornblende granite and granodiorite to biotite granodiorite (most common) and biotite quartz diorite. BARNES (1952) describes them as mainly quartz diorite, which are pink and grey, holocrystalline, mesocratic to leucocratic, medium to coarse grained.

TABLE VII

Thin Section Descriptions

Sample Number	Classification	Main Minerals
E-12-73-2	Diorite	Chl., 20%; fsps., 60-70%; Apa.;
B.I.2.71	Diorite	Hb., Bio., 20%; fsps., 60%; Apa.; Hem-Mag.;
E-11-73-6D	Diorite	Hb., Chl., 15-20%; Carb., 15%; fsps.,
E-8-73-1(2)	Diorite	Chl., Hb., Trem-Act., 30%; Carb., 5%; Fsps., 60%;
E-12-73-11	Diorite	Hb., 25%; Carb., 10%; Fsps., 60%;
E-14-73-2	Diorite	Chl., 15%; Fsps., 70%; Apa.; Hem-Mag.;
E-12-73-5	Syenite	Chl., 4%; Fsps., 60%; Carb., 30%;
E-12-73-3	Diorite-Syn.	Fsps., 80%; Carb., 10%; Bio.; Hb.; Chl.
E-11-73-7B	Syenite	Carb., 10%; Chl.; Fsps., 80%; Mag.;
E-11-73-7A	Differentiate	Carb., 40%; Fsps., 30%; Apa.; Chl., 30%;
E-10-73-8	Syenite	Chl., 5%; Hb., 5%; Fsps., 85%;
E-16-73-1	Diorite	Chl., 10%; Hb., 10%; Fsps., 60%; Qtz.;
DDH-12-1'	Diorite	Hb., 24%; Bio., 1%; Fsps., 75%;
DDH-12-8.5'	Diorite	Hb., 20%; Chl., 3%; Trem-Act., 2%; Carb., 5%; Fsps., 70%;
DDH-12-12'	Diorite	Hb., 18%; Chl., 5%; Trem-Act., 2%; Fsps., 70%;
DDH-12-20.5'	Diorite	Hb., 15%; Chl., 7%; Trem-Act., 3%; Apa.; Mag-Hem.; Fsps., 70%;
DDH-12-25.5'	Diorite-Syr.	Hb., Chl., 15%; Carb., 15%; Fsps., 70%;
DDH-12-29'	Syenite	Trem-Act., 7%; Carb., 20%; Fsps., 60%;
DDH-15-1'	Diorite	Hb., Chl., Trem-Act., 25%; Carb., 2%; Fsps., 70%;
DDH-15-4'	Syenite	Hb., Trem-Act., 5%; Fsps., 80-90%;

continued

Sample Number	Classification	Main Minerals
E-9-73-3	Meta-Sed	Carb., 70%; Hb., Chl., Epi., Fsps.;
E-9-73-4	Meta-Sed	Amphi., 40%; Fsps., 60%;
E-9-73-4A	Meta-Sed	Carb., 80%; Fsps., 10%; Mafics, 10%;
E-9-73-5(2)	Meta-Sed	Hb.; Mag-Hem.; Carb.; Fsps.;
E-9-73-7	Meta-Sed	Trem-Act.; Hb.; Fsps.;
E-10-73-1	Meta silt	Mafics, 20%; Clay min., 20%; Carb., 60%;
E-10-73-2	Hornfels	Hb., 45%; Chl., 15%; Carb., 20%; Fsps.;
E-10-73-3	Hornfels	Chl., Hb., 80%; Carb., 15%; Fsps., 5%;
E-10-73-4	Meta-Lst.	Cal., 95%; clay min., 5%; Mag-Hem.;
E-10-73-5	Meta-Lst.	Cal-Dol., 85%; Trem-Act.; Clay min.;
E-10-73-6	Hb-Hornfels	Hb., Trem-Act., 85%; Mag-Hem., 5%; Fsps., 10%;
E-10-73-7	Hb-Hornfels and Syenite	Hb., 80%; Fsps.; Carb.; Apa.;
E-10-73-9	Hb-Hornfels	Hb., 85%; Fsps., 10%;
E-10-73-10	Hb-Hornfels	Hb., Trem-Act., 70%; Fsps., 20%; Mag.;
E-10-73-10A	Hb-Hornfels	Hb., Trem-Act., 70%; Fsps.; Mag-Hem.;
E-11-73-1	Meta-Sed	Carb.; Mafics; Clay min.;
E-11-73-2	Hb-Hornfels	Hb.; Hem-Mag.; Epi.; Fsps.;
E-11-73-3	Meta-Sed	Car.; Mafics; Clay min.;
E-11-73-4	Meta-Shale	Mag-Hem.; Trem-Act.; Hb.; Qtz., 15%; Fsps., 65%;
E-11-73-5A(2)	Hb-Hornfels	Hb., 85%; Chl., 5%; Trem-Act., 2%; Fsps., 65%;
E-11-73-6A	Hb-Hornfels	Mag.; Hb., Trem-Act., 80%; Carb.; Fsps.;

continued

Sample Number	Classification	Main Minerals
E-11-73-6B	Meta-Lst.	Chl.; Hb.; Fsps.; Carb., 80%;
E-11-73-6C	Meta-sed	Mag-hem.,40%; Carb.;Fsps., Hb., Trem-act., 20%;
E-11-73-6D	Meta-sed	Mag-hem.; Carb.; Fsps.; Hb., Trem-act.;
E-11-73-6E	Meta-Lst.	Hb., Mag-hem.; Fsps.; Carb., 80%;
E-11-73-6F	Meta-Lst.	Chl., Hb., 30%; Fsps., 10%; Carb., 60%;
E-12-73-1	Hornfels	Mag-hem.; Hb., Trem-act., 60%; Fsps.; Chl., 10%;
E-12-73-4	Hb-Hornfels	Hb., Trem-act., 70%; Carb., 4%; Fsps., 20%; Mag-hem.;
E-12-73-4A	Hb-Hornfels	Mag-hem.; Carb.; Hb, Trem-act., 60%; Fsps.;
E-12-73-6	Meta-Lst.	Carb., 80%; Fsps.,Clay Min.;
E-12-73-7	Hb-Hornfels	Mag-hem.; Carb.; Chl., Hb., Trem-act., 60%; Fsps.;
E-12-73-8	Meta-shale	Carb., 30%; Fsps., 60%; mafics;
E-12-73-9(2)	Meta-Lst.	Clay Min.; Carb., 60%; Fsps.; Mafics;
E-12-73-10	Meta-sed	Mag-hem.; Apatite, Hb.; Carb., 35%; Fsps., 35%;
E-14-73-10	Meta-Lst.	Chl.; Fsps.; Carb., 80%;
E-14-73-9	Hornfels	Chl., Trem-act., 60%; Fsps.; Carb.; Hem.;
E-14-73-8	Breccia	Fsps., 60%; Carb., 30%; Chl., Trem-act.;
E-14-73-7	Hb-Hornfels	Fsps., 10%; Hb., 85%; Hem.; Trem-act.;
E-14-73-6	Meta-Lst.	Carb., 90%; Clay Min., 10%;
E-14-73-5	Breccia	Carb., 35%; Fsps., 65%;
E-14-73-4	Meta-Lst.	Carb., 70%; Fsps., 30%;
E-14-73-3	Meta-shale	Carb., 20%; Fsps., 60%; Hb., Chl., 15%;

continued

Sample Number	Classification	Main Minerals
DDH-15-8.75'	Diorite	Hb., Trem-Act., 25%; Fsps., 60-70%;
DDH-15-9'	Syenite	Carb., 5%; Fsps., 90%;
DDh-15-10'	Diorite	Hb., Chl., Trem-Act., 25%; Carb., 5%; Fsps., 70%;
DDH-15-13'	Diorite	Hb., 25%; Apa.; Fsps., 70%;
DDH-15-17.5'	Diorite	Hb., Chl., 20%; Carb., 5%; Fsps., 75%;
DDH-15-20'	Diorite	Hb., Chl., 20%; Carb., 5%; Fsps., 70%; Mag-Hem.;
DDh-15-28'	Diorite	Chl., Hbl., 15%; Fsps., 80%;
DDH-15-31'	Diorite	Chl., Hb., 25%; Fsps. 75%;
DDH-15-35'	Diorite	Hb., Chl., 20%; Fsps. 75%;
DDH-15-38'	Syenite	Carb., 30%; Trem-Act., 2%; Fsps., 65%;
DDh-15-40'	Syenite	Trem-Act., 5%; Carb., 10%; Fsps., 80%;
E-16-73-9	Hornfels	Trem-Act., 80%; Fsps., 10%; Carb., 10%;
E-16-73-8	Meta-Shale	Trem-Act., 40%; Fsps., 40%; Carb., 20%;
E-16-73-4(2)	Meta.Dol.	Cal-Dol.; Trem-Act.; Fsps.;
E-16-73-3A(2)	Meta-Lst.	Carb., 70%; Fsps., 20%; clay min., 5%; Trem-Act., 5%;
E-16-73-7	Meta-Shale	Hb.; Chl.; Fsps.; Carb.;
E-16-73-6	Meta-Lst.	Hb.; Chl.; Fsps.; Carb.;
E-16-73-5	Hornfels	Hb., Chl., 70%; Carb., 10%; Fsps. 10%;
E-16-73-2	Meta-Lst.	Carb., 85%; Chl., Hb., 15%;
E-9-73-1	Meta-sed	Trem-Act-35%; Epi., 1%; Fsps., 50%; Apa.; Mag-Hem.;
E-9-73-2	Meta-sed	Hb.; Epi.; Fsps.; Carb.; Mag-Hem.;

continued

Sample Number	Classification	Main Minerals
E-14-73-1	Meta-Lst.	Carb., 70%; Fsps., 30%;
E-15-73-1	Meta-Shale	Apa., 2%; Hb., 10%; Fsps., 80%; Mag-Hem.;
E-15-73-2	Hb-Hornfels	Hb., Trem-Act., 95%; Fsps.;
E-15-73-3	Hb-Hornfels	Hb., 60%; Epi., 20%; Fsps., 60%;
E-15-73-4	Meta-Lst.	Carb., 80%; Clay min.;
E-15-73-5	Breccia	Carb., 30%; Mafics., 10%; Fsps., 60%;
E-15-73-6	Meta-Sed	Carb.; Clay min.; Mafics.; Fsps.;
E-15-73-7	Meta-Sed	Mafics, 5%; Carb., 50%; Fsps., 45%;

Abreviations used: Hb= Hornblende, Trem-Act= Tremolite-Actinolite Meta= metamorphosed, Lst= limestone, dol= dolomite, Chl= chlorite, Bio= Biotite, Clay min= clay minerals, Mag-Hem= Magnetite-Hematite, Carb= carbonate, Syn= Syenite, Qtz= quartz, Epi= epidote, Apa= Apatite, Fsps= feldspars.

Since this study involves descriptions of the rocks around the mine area which may have undergone hydrothermal alteration, it is understandable that the descriptions presented here will differ from those above.

Opaque Minerals

A. Magnetite-hematite

It appears that in all cases, these minerals were formed in the late stages of crystallization. The textural information shows that the opaques are often replacing or cross-cutting the mafic minerals. Concentrations of the opaques vary from sample to sample. Generally, they compose 2 to 3 percent of the rock, but one sample contained up to 25 percent. This particular sample is an example of a late stage differentiate of the sill.

Transparent Minerals

A. Hornblende

The amount of hornblende varies from sample to sample. Away from the contact and away from the mine area, a sample can contain up to 20 to 25 percent hornblende, but as the contact is approached this percentage can drop to zero as the mafics are replaced. The hornblendes are generally of a highly pleochroic green color, but it is not uncommon to find the brown variety. The crystals are usually euhedral, but are very fine grained. There is some textural evidence which indicates that the hornblende crystallized after the feldspars but before or synchronous with the opaque minerals. Nearer the contact, the hornblendes are generally

replaced by carbonate and chlorite, and often show degrees of alteration which all but mask the crystal's optical properties. This alteration has not been defined.

B. Tremolite-actinolite

The tremolite-actinolite series occurs in most of the specimens. It occurs as two distinct stages. Firstly, it can occur as early stage crystals probably synchronous with the formation of the hornblendes. This type is exemplified by euhedral radiating crystals. Secondly, it occurs as late stage veins which are usually in association with carbonate veins. These veins cross-cut all minerals and occur with increasing regularity as one approaches the contact. In both cases, it is pleochroic light green tremolite and actinolite.

C. Chlorite (Prochlorite or Clinochlore)

Chlorite also appears to exhibit at least two, and possibly three, stages. Firstly, it may have precipitated early, crystallizing along with hornblende and tremolite-actinolite. Secondly, it may replace the other amphiboles. Thirdly, it may occur as veins. Regardless of the stage, the chlorite is usually very pleochroic and generally occurs to a maximum of 5 percent in the sample.

D. Epidote

Epidote occurs as a minor constituent (2 percent) in most of the samples. It is usually associated with the first stage of chlorite and there is evidence pointing to the fact that it replaces hornblende.

E. Biotite

Biotite is rare in these specimens. It was found in only two of the 31 igneous specimens studied, and even then it made up less than 1 percent of the samples. These two specimens were collected well away from the contact.

F. Apatite

Apatite is found as a minor constituent of many of the samples. It usually occurs as very small euhedral crystals.

G. Quartz

Quartz is noticeably absent in all the samples except E-16-73-1. This sample was gathered well away from the contact. Quartz made up approximately 3 to 5 percent of the sample.

H. Calcite

At least two stages of calcite are found in these rocks. First, there is a replacement stage in which calcite, often fine grained, is found replacing some of the mafics. Secondly, there is a late stage calcite, occurring as veins, which generally cuts all other minerals. Most of the samples contain approximately 5 percent calcite, but one sample contains 40 percent. This unusual carbonate and chlorite rich (feldspar poor) sample is thought to be a late stage differentiate of the sill.

I. Feldspars

The feldspars in all the samples are badly altered, usually to fine grained micas. Away from the contact, we find large phenocrysts of plagioclase, but these diminish in size as the

contact is approached. Feldspars in these rocks usually make up 70 percent of the sample when mafics are present and up to 90 percent when they are not. The feldspars in the rocks near the contact are almost entirely albite. This suggests an event of sodium metasomatism in these rocks. Generally, the rocks away from the contact consist of andesine and oligoclase with minor amounts of albite. The feldspars other than those occurring as phenocrysts, are generally cut by the mafics and the opaques.

Conclusions

It has been noted that away from the contact, the rocks are mainly of a dioritic composition and are generally mafic rich. Nearer the contact, the mafics disappear and the rock becomes syenitic. One of the drill holes studied in detail is even more complex than this. Dioritic compositions are found on surface grading to syenitic, grading to dioritic, grading to syenitic, grading to dioritic and back to syenitic along the contact. The intermediate syenitic beds are rarely more than 2 feet thick.

The terms dioritic and syenitic are probably misused in the area. The syenitic compositions are probably a reflection of albitization. That is, these rocks have undergone a great deal of alteration, either by remobilized metamorphic solutions or later hydrothermal solutions. This albitization may also be a reflection of the environment upon intrusion, which one would have to conclude was very wet. The marine water could have been a source of the sodium. This idea is also supported by the amount of sericitization the feldspars, which appears to be greater in this area than elsewhere in the East Arm.

The amount of carbonate replacement and veining increases as we approach the contact. This feature is probably due to the circulation of calcareous metamorphic fluids in the contact area.

Country Rocks Away From the Contact

Upon examination of the country rocks away from the contact, it is found that after the first 100 feet down-section, the limestones appear to be only slightly metamorphosed. Occasionally, one finds anomalous coloration of the normal grey weathering limestones, but this is rare.

Due to the relatively gentle dips in the area and the proximity of the sill to the shore, only 200 feet, at most, of the section below the contact may be studied. The sequence of rocks exposed are generally thinly bedded limestones occasionally containing argillite beds up to 4 inches thick. The limestones are recrystallized and contain hornblende and chlorite dispersed in a calcareous matrix. Sometimes, feldspathic minerals are present in bands representing remnant argillite beds. These limestone beds contain secondary calcite veins and sometimes, associated tremolite-actinolite veins which cross-cut the samples irregularly.

The impure dolomite beds exhibit the greatest effects of metamorphism. Often these beds contain concentrations of hornblende and chlorite in excess of 70 percent. They would be defined as hornblende-hornfelses. The only differences between a hornfels found 200 feet stratigraphically from the contact and those near the contact, is the grain size of the mafics and perhaps the absence of epidote and apatite. It seems that these argillites or pelites,

as they are now, suffered from a lesser, but still significant degree of metamorphism than those along the contact. Metamorphic solutions must have reached this far and a degree of metasomatism must have occurred.

Country Rocks in the Mine Area

The area appears to be characterized by both lateral and vertical variations in rock type, which makes it difficult to correlate the units. Field mapping indicated 16 distinct units, divided on the basis of color, grainsize, cementation, and amount of deformation. Below are listed the units, their classifications and their individual characteristics.

The term hornfels used below is used in its broadest sense to describe units that have been metamorphosed, are fine grained, and are wholly recrystallised. Texture was not a limiting factor in the naming, but usually the crystals are disoriented. Similarly, the term skarn was used in its broadest sense, but iron enrichment was a prerequisite to the naming.

Unit 1: Dioritic to Syenitic Sill

This unit was described previously(page 57).

Unit 2: Calcareous hornfels

The unit applies to a series of limestones which weather grey or brown and generally show little sign of metamorphism on the surface other than recrystallization. The unit is generally thinly bedded and comprises approximately one third of the outcrop area. In thin section, this unit consists mainly of calcite with minor amounts of dolomite. The mafic content is usually less than 5 percent

dispersed in the matrix. The feldspar or clay mineral content varies, and occurs as intermittent bands which are very thin and usually strongly folded.

Unit 3: Hornblende-Hornfels

This unit is just one example of many beds of hornblende-hornfels occurring in the area. Hornblende usually makes up about 80 percent of the samples, and occurs as either distinct beds or as blocky aggregates dispersed in the matrix. The matrix is either feldspathic or calcareous. Apatite as well as hematite and magnetite occur in most of the samples. Later deformation is accompanied by tremolite-actinolite or carbonate veining. In the field, this unit is pink weathering with fresh surfaces of alternating pink and dark green bands. The unit is generally non-calcareous.

Unit 4: Hornblende-Chlorite Skarn

This unit consists of pink to dark green, calcareous, fine grained, thinly bedded rocks. It is usually highly fractured. As a whole, the samples consist of 60 percent carbonate, 10 percent feldspars, and 30 percent mafics (hornblende, chlorite, and tremolite-actinolite). The samples are banded, with bands that are mafic rich alternating with bands that are mafic poor, and carbonate rich, alternating with bands that are magnetite-hematite rich. Near the contact, there is an increase in carbonate and tremolite-actinolite veins resulting in an increasing alteration of the mafics.

Unit 5: Hornblende-Hornfels

Field descriptions indicate that this unit is a very dark green, fine grained, thinly bedded, resistant and well cemented rock. Thin section examinations reveal that the rock consists of 80 percent hornblende, 10 percent feldspars and 10 percent carbonate. The samples contain magnetite, hematite, apatite, and varying quantities of tremolite and actinolite as accessory minerals. As the contact is approached, the samples contain more magnetite and hematite. In some samples, banding is still apparent, but in others, the banding is masked by the influx of mafics. Around the brecciated zone (Unit 7) in particular, there is a significant increase in the amount of tremolite-actinolite and carbonate veining. The hornblende varies in both grain size and pleochroism. For example, the mine area (Unit 7) is characterized by very coarse grained, pleochroic hornblende; but to the south, the unit is very fine grained.

Unit 6: Hornblende-Hornfels

In the field, this unit consists of pink feldspathic bands alternating with dark green amphibole rich bands. It is thinly bedded and fine grained. Thin section examinations indicate that the sample consists of 70 percent mafics (hornblende, tremolite-actinolite), 20 percent feldspars in the form of porphyroblasts, and about 5 percent carbonate. The hornblende is pleochroic green and brown.

Unit 7: Carbonate Breccia

This unit in the field is very distinctive, consisting of dark

red feldspathic angular pieces imbedded in a white calcite matrix. Thin section examinations indicate that calcite makes up 35 percent of the sample and feldspars 65 percent. Of course, these ratios would be sample dependent. It is with this breccia that the nickel-cobalt mineralization is associated.

Unit 8: Magnetite Skarn

In the field, this unit is a pink to light brown weathering, thinly bedded meta sediment. It consists of feldspathic bands alternating with hematitic bands.

Unit 9: Hornblende-Epidote Hornfels

In the field, the rock consists of thinly bedded hematitic layers alternating with dark and light green bands. Thin section examination indicates the sample contains 60 percent hornblende, 20 percent epidote, and 20 percent feldspar matrix. The unit is banded with these minerals occurring in distinct layers.

Unit 10: Hornblende Skarn

In the field, these rocks are very fine grained and vary in color from pink in the south to dark green in the north. Thin section examination indicates that to the south and away from the mine area, the unit is mainly carbonate, often containing calcite porphyroblasts. In this area, mafics make up about 20 percent of the bulk composition and feldspars about 10 percent. However, moving to the north and along strike, both the mafic and the feldspar content increases.

Unit 11: Hornblende-Epidote-Hornfels

In the field, this unit consists of thin beds of dark green, light green and red minerals. The unit is well cemented, non-calcareous and still has many of its sedimentary features intact. Thin section examinations indicate that the dark green bands are hornblende, the light green bands are epidote and the red bands are feldspathic. The rock contains a greater percentage of hornblende than epidote or the feldspathic minerals.

Unit 12: Hornblende Hornfels

In the field, this rock unit is fine grained, grey weathering, thinly bedded and well cemented. Thin section examinations indicate the samples consist of 70 percent hornblende and tremolite-actinolite, and 30 percent feldspars. There is an increase in mafics toward the mine area. The samples contain both carbonate and tremolite-actinolite veins, increasing toward the mine area. Apatite, hematite, and magnetite are present in minor quantities.

Unit 13: Pelite

In the field, this unit consists of alternating pink and dark green, hematite-rich bands. Thin section examinations indicate that the samples consist of 65 percent feldspars, 10 percent carbonates and 10 percent mafics (hornblende and tremolite-actinolite). Magnetite and hematite are found in all samples. Highly folded chloritic bands are occasionally found. The samples are cross-cut by later carbonate veins.

Unit 14: Hornblende Hornfels

This unit weathers white to buff; it is thinly bedded, well cemented and light green in color. Thin section examinations indicate the bulk composition is 10 to 15 percent prochlorite, 45 percent hornblende, 20 percent carbonate and 10 percent feldspars. These minerals are dispersed in the matrix and banding is not apparent on this scale.

Unit 15: Hornblende Hornfels

Thin section examinations indicate that this rock consists of 85 percent hornblende and 10 percent feldspars. The samples have undergone later carbonate veining. The rocks in the field are green, thinly bedded, well cemented and non-calcareous.

Unit 16: Pelite

In the field, this unit is very fine grained, well cemented, thinly bedded and black to dark green in color. Thin section examinations indicate a fine grained feldspathic matrix containing numerous tremolite-actinolite needles and small blocks of hornblende. The rock is cut by carbonate and tremolite-actinolite veins.

Discussion

From thin section examinations, the following conclusions can be reached:

a. Field evidence and thin section evidence indicates that rock units in the area of Unit 7 have not only undergone metamorphic reactions but they also have undergone later hydrothermal alteration.

This subsequent hydrothermal alteration has eradicated many of the metamorphic effects.

b. Thin section evidence indicates that there is an increase in carbonate and tremolite-actinolite veining along the sill contact and toward the mine area. This observation is a reflection of the amount of mobilization that must have occurred in the area due to metamorphic fluids and later hydrothermal fluids.

c. Field evidence, supported by thin section evidence, indicates that processes of metasomatism took place. In fact, certain areas appear to be more severely metamorphosed and metasomatized than others along strike. This feature may be a reflection of differential migration of metamorphic derived fluids along fault or joint planes, such that one area becomes more altered than the next. If, however, faulting occurred before the sill intruded, then units of different porosities may be in contact with one another and metamorphism and metasomatism may be more severe in one unit than the other.

d. Thin section evidence indicates that even up to the contact, the rocks are in the 'Hornblende-Hornfels' facies of metamorphism. Farther away from the contact, however, there is a prevalence of epidote and tremolite-actinolite in the rocks. This is only a narrow, ill-defined zone, but it may represent the albite-epidote-hornfels facies, (TURNER, 1968).

e. Thin section evidence indicates that certain metasomatic reactions must have taken place. Hornblende, tremolite, actinolite, chlorite, epidote, apatite, hematite, magnetite, and certain feldspars all must have arisen through the processes of metamorphism and

metasomatism. Complex reactions may be written to accommodate these minerals into this environment, but more generally, it can be hypothesized that the reaction of an impure limestone and interbedded argillite units with iron, sulphur, and carbonate rich metamorphic fluids would give rise to the above listed minerals. The origin of iron and sulphur for the formation of the skarns may arise in the following manner. It is known that the area of Blanchet Island is transected by a lithostratigraphic boundary separating a platform shelf sequence from a terrigenous basinal sequence of sediments. Recent work on such environments in the Cordillera (GABRIELSE, 1972) has shown a concentration of mineralization along such transecting boundaries. Solutions from the basins could dissolve pyrite from the greywackes and shales and redeposit iron sulphides along the shelf-basin boundary. With the intrusion of the Blanchet Island sill, metamorphic fluids could remobilize these minerals making them available for skarn development.

f. The thin section study revealed a noticeable lack of quartz in both the sill and the sediments. This study is contrary to the findings of BARNES and WRIGHT mentioned above. The sill on Blanchet Island therefore represents a stage of differentiation not found further East in the aulacogen. This feature may be a reflection of the environment of intrusion; it may be a reflection of the thickness of sediments intruded or it may be an indication of the magmatic differentiation processes that occurred among these sills and dykes in the East Arm.

Summary

In general, the area was characterized by a great deal of fluid migration. The sill is badly altered, and in some places, there is evidence of sodium metasomatism which may have been a consequence of either metamorphic fluids or later hydrothermal fluids. The sediments, which are now metamorphosed, occupy mainly the hornblende-hornfels facies of metamorphism, and they may grade outward into the albite-epidote-hornfels facies.

CHAPTER SEVEN

CONCLUSION AND ECONOMIC OUTLOOK

Eighteen hundred million years ago, the sill on Blanchet Island, N.W.T. intruded a synclinorium superimposed on a minor graben situated on the south part of the island. Later, transcurrent wrench faulting occurred along the faults, that form the graben. This movement effectively slid the sill over the underlying sediments, creating drag folds along the contact. Where the folds were sharp enough to cause brecciation of the anticlinal apices, mineralization occurred. The source of the mineralizing fluids is questionable. They may be the result of leaching by late stage metamorphic fluids, or they may be fluids percolating upwards from the underlying Seton Volcanics. Finally, they may be fluids rising from deep in the crust, or in the upper mantle, perhaps rich in nickel and cobalt due to the serpentinization of an olivine rich magma. Regardless of its origin, the result was an ore deposit consisting mainly of massive niccolite, rammelsbergite and safflorite.

The sill, as well as the underlying sediments, are characterized by varying degrees of alteration, resulting either from mobilized metamorphic fluids or later hydrothermal solutions. The sill has suffered albitization, especially along the contact. Both the sediments and the sill are cross-cut by carbonate and tremolite-actinolite veins. The intrusion of the sill caused contact metamorphism of the sediments. This metamorphism is of the hornblende-hornfels facies grading outwards to the albite-

epidote-hornfels facies.

Economic Outlook

The folds that seem to control the mineralization are small and die out quickly with depth. It stands to reason, then, that the ore bodies are small. The body studied here was only 200 tons, and the next largest showing known is only 50 tons. If these folds persist throughout the island under the sill, then what is observed on the exposed contact may only be a fractional representation of what might exist underneath. Many more of these 200-ton ore bodies of the grade typified by the surface showings would make Blanchet Island an area of economic importance. Preliminary assays on this 200 ton ore body released by Jason Explorations Ltd. show 15% nickel, 10% cobalt, plus 5% bismuth and 60% arsenic. The problem would be to locate the potential ore bodies under the sill. Perhaps by studying the existing joint patterns of the sill the underlying fold patterns could eventually be resolved, if they existed. Such a study would involve detailed mapping of the joints. Geophysical techniques may be employed to resolve these hypothetical ore bodies, but the prevalence of magnetite-hematite skarns associated with the ore bodies may make resolution difficult, if not impossible.

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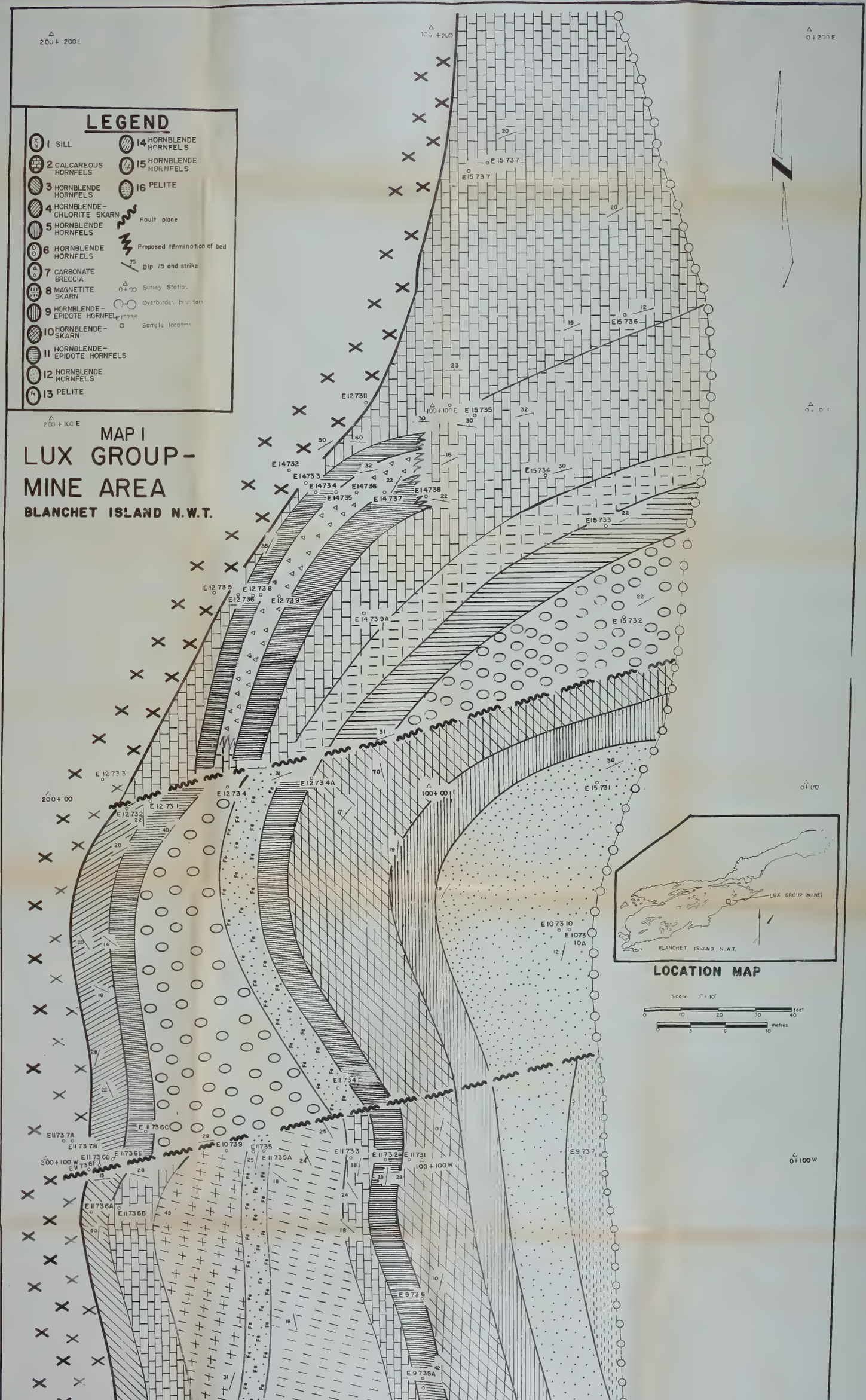
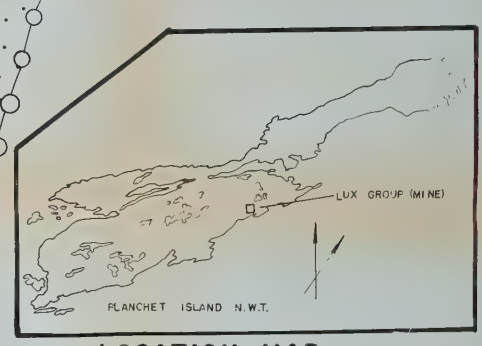

LEGEND
1 SILL
2 CALCAREOUS HORNFELS
3 HORNBLENDE HORNFELS
4 HORNBLENDE-CHLORITE SKARN
5 HORNBLENDE HORNFELS
6 HORNBLENDE HORNFELS
7 CARBONATE BRECCIA
8 MAGNETITE SKARN
9 HORNBLENDE-EPIDOTE HORNFEL
10 HORNBLENDE-SKARN
11 HORNBLENDE-EPIDOTE HORNFELS
12 HORNBLENDE HORNFELS
13 PELITE
14 HORNBLENDE HORNFELS
15 HORNBLENDE HORNFELS
16 PELITE
Fault plane
Proposed termination of bed
Dip 75 and strike
Survey Station
Overburden Boundary
Sample location
MAP I
LUX GROUP-
MINE AREA
BLANCHET ISLAND N.W.T.
LUX GROUP (MINE)
BLANCHET ISLAND N.W.T.
LOCATION MAP
Scale 1" = 10'
feet
metres

MAP I
LUX GROUP-MINE AREA
BLANCHET ISLAND N.W.T.

1 SILL
2 CALCAREOUS HORNFELS
3 HORNBLENDE HORNFELS
4 HORNBLENDE-CHLORITE SKARN
5 HORNBLENDE HORNFELS
6 HORNBLENDE HORNFELS
7 CARBONATE BRECCIA
8 MAGNETITE SKARN
9 HORNBLENDE-EPIDOTE HORNFEL
10 HORNBLENDE-SKARN
11 HORNBLENDE-EPIDOTE HORNFELS
12 HORNBLENDE HORNFELS
13 PELITE
14 HORNBLENDE HORNFELS
15 HORNBLENDE HORNFELS
16 PELITE

Fault plane
Proposed termination of bed
Dip 75 and strike
Survey Station
Overburden boundary
Sample location



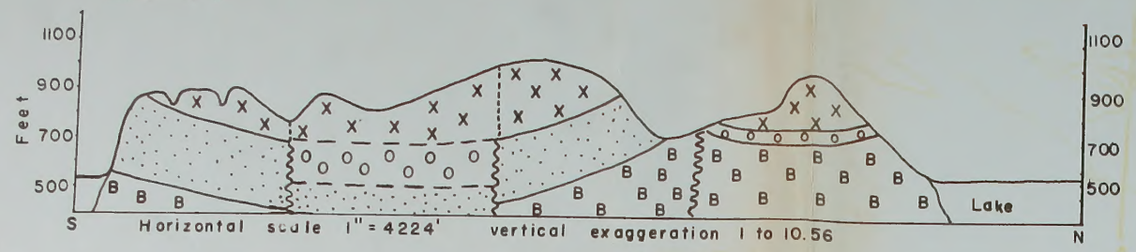
LOCATION MAP

Scale 1" = 10'
feet 0 10 20 30 40
metres 0 3 6 10

LEGEND

- X Sill
- O Stark Formation
- J Hearne Formation
- L Wildbread Formation
- Pekanatui Formation
- B McLean Formation
- T Utsingi Fonmation
- W Taltheilei Formation
- I Douglas Penninsula Formation
- n Charlton Bay Formation
- ? unmapped

Section A · A'



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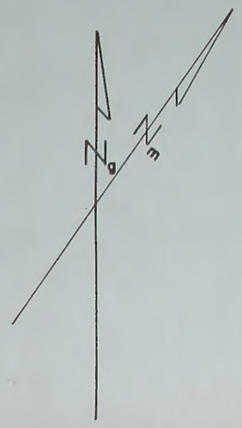

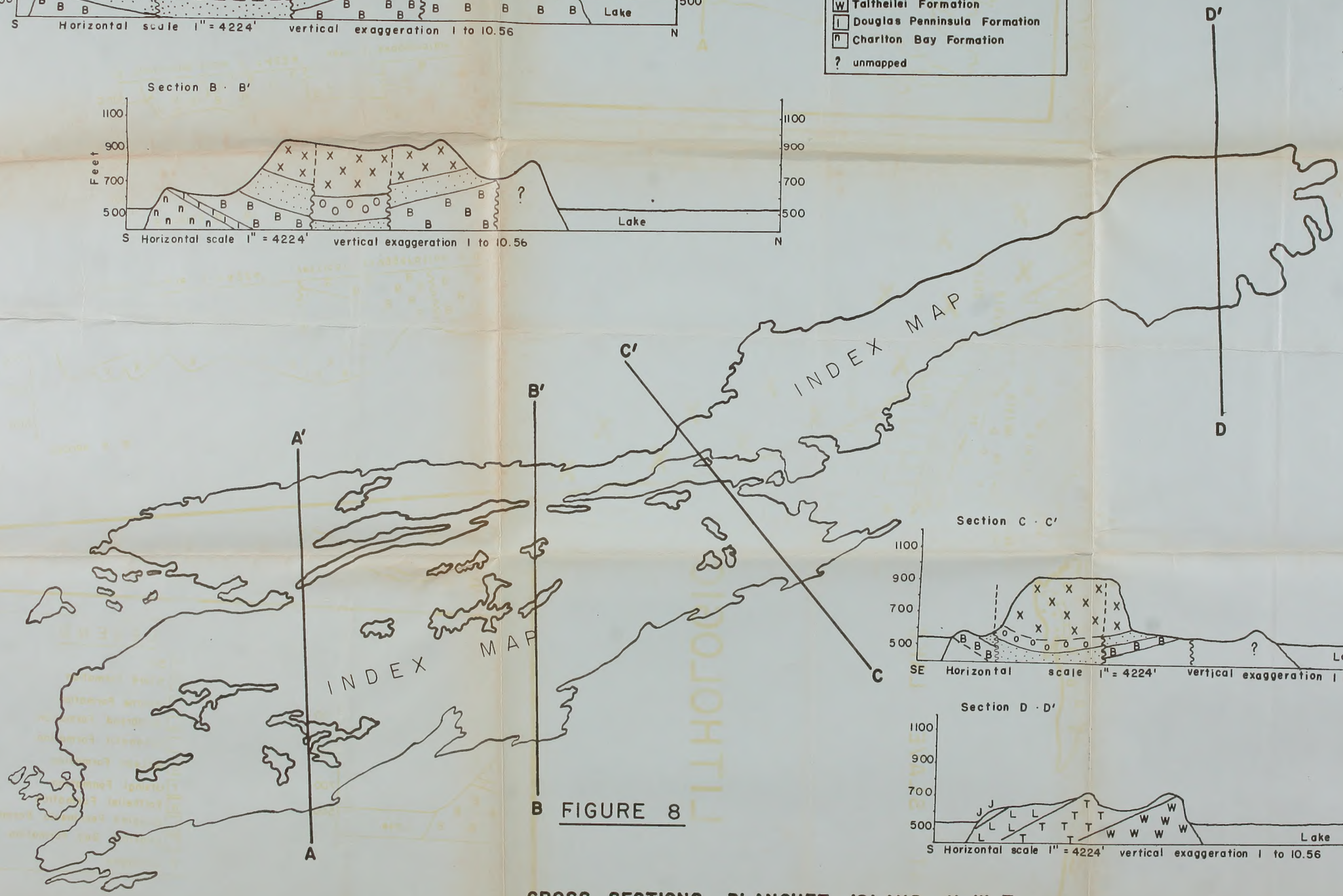

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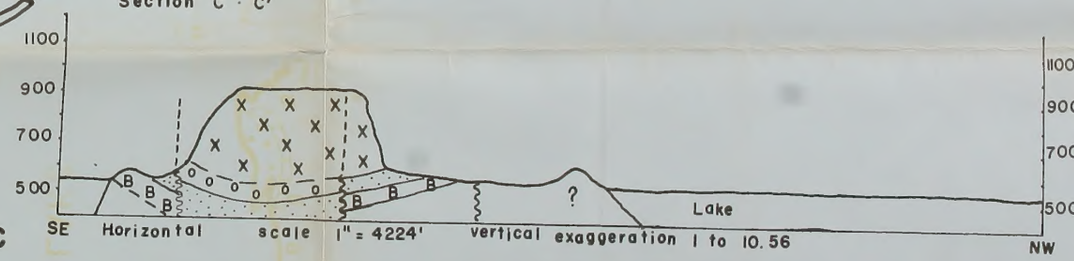

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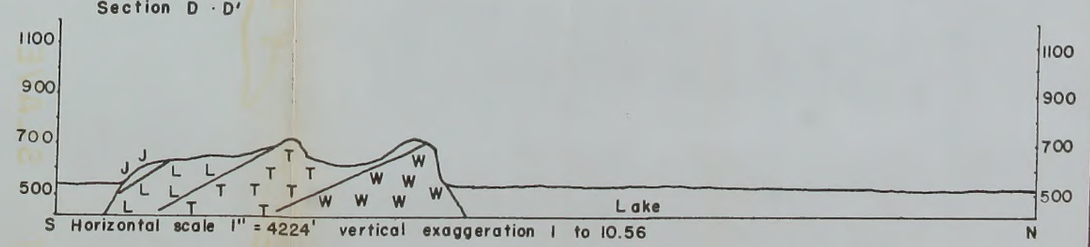


FIGURE 8

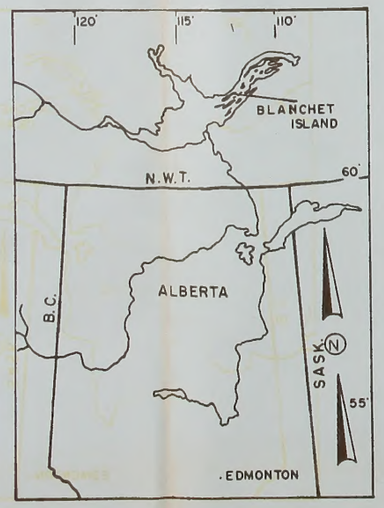
CROSS SECTIONS BLANCHET ISLAND N. W. T.

HEARNE CHANNEL

UNMAPPED

BLANCHET ISLAND

GREAT SLAVE LAKE



SCALE 1:50,000

1 0 1 2 3 miles

1000 0 1000 2000 4000 metres

APHEBIAN

MAP 2

LITHOLOGIC MAP BLANCHET ISLAND N. W. T. CANADA 1973

HEARNE CHANNEL

UNMAPPED

E T

I S L A N D

SETON ISLAND

GREAT SLAVE LAKE

SCALE 1:50,000

1 0 1 2 3 miles

1000 0 1000 2000 4000 metres

LEGEND

APHEBIAN

- X Sill
- O Stark Formation · Mudstone
- J Hearne Formation · Limestone
- L Wildbread Formation · Limestone
- ⁘ Pekanatui Point Formation · Limestone
- B McLean Formation · Argillite
- T Utsingi Formation · Limestone
- W Taltheilei Formation · Dolomite
- l Douglas Penninsula Formation · Marlstone
- n Charlton Bay Formation · Argillite
- h McLeod Bay Formation · Shale
- c Gibraltar Formation · Shale
- V Seton Formation · Volcanics

After P. Hoffman unpublished

MAP 2

LITHOLOGIC MAP BLANCHET ISLAND N. W. T. CANADA 1973

B30083